SCiDUC Symposium
May 30th, 2024

SCiDUC
SC INTERAGENCY DRONE USERS CONSORTIUM

SCiDUC Inaugural Symposium

Pushing State Agencies Into the Sky

Welcome!

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May 30th, 2024

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Please find your Seats

We will start shortly

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Pushing State Agencies Into the Sky

Welcome!

South Carolina Aeronautics Commission
Unmanned Aircraft System (UAS) Program

David Smith
UAS Program Manager

South Carolina Aeronautics Commission

SCIDUC
Columbia, SC

Defining The Need

- **Airports losing approaches due to obstructions**

- **Obstruction identification and removal process has limitations**
  - Ground survey limitations
  - Costly for GA Airports to perform full scale traditional aerial mapping
  - Procuring full scale aerial mapping takes time
  - Outdated information in FAA database

Fixing the problem
The Unmanned Aircraft System

- **Other benefits**
  - 5010 inspections
  - Support as needed for FAA/NTSB in accident response
  - Assist with state's land use and compatibility program
  - Support other South Carolina state agencies with aerial imagery

UAS Program Goal

- Our goal is to provide high quality data sets for South Carolina airports that enable them to better manage the obstruction coordination and removal process. The integration of an Unmanned Aircraft System (UAS) along with GIS and our core safety initiatives are the foundation for our GIS program.

SenseFly eBee X

Aeropoints Ground Target

Advantages of using a UAS

- Cost savings (average single airplane $300/hr versus pennies for charged batteries)
- Provide very accurate datasets
- Time savings
- On-demand mapping and aerial photography
- Data validation for SCAC Compatible Land Use Tool process
- Data validation for AIP construction projects
- Assistance with state emergency response needs

Disadvantages of using a UAS

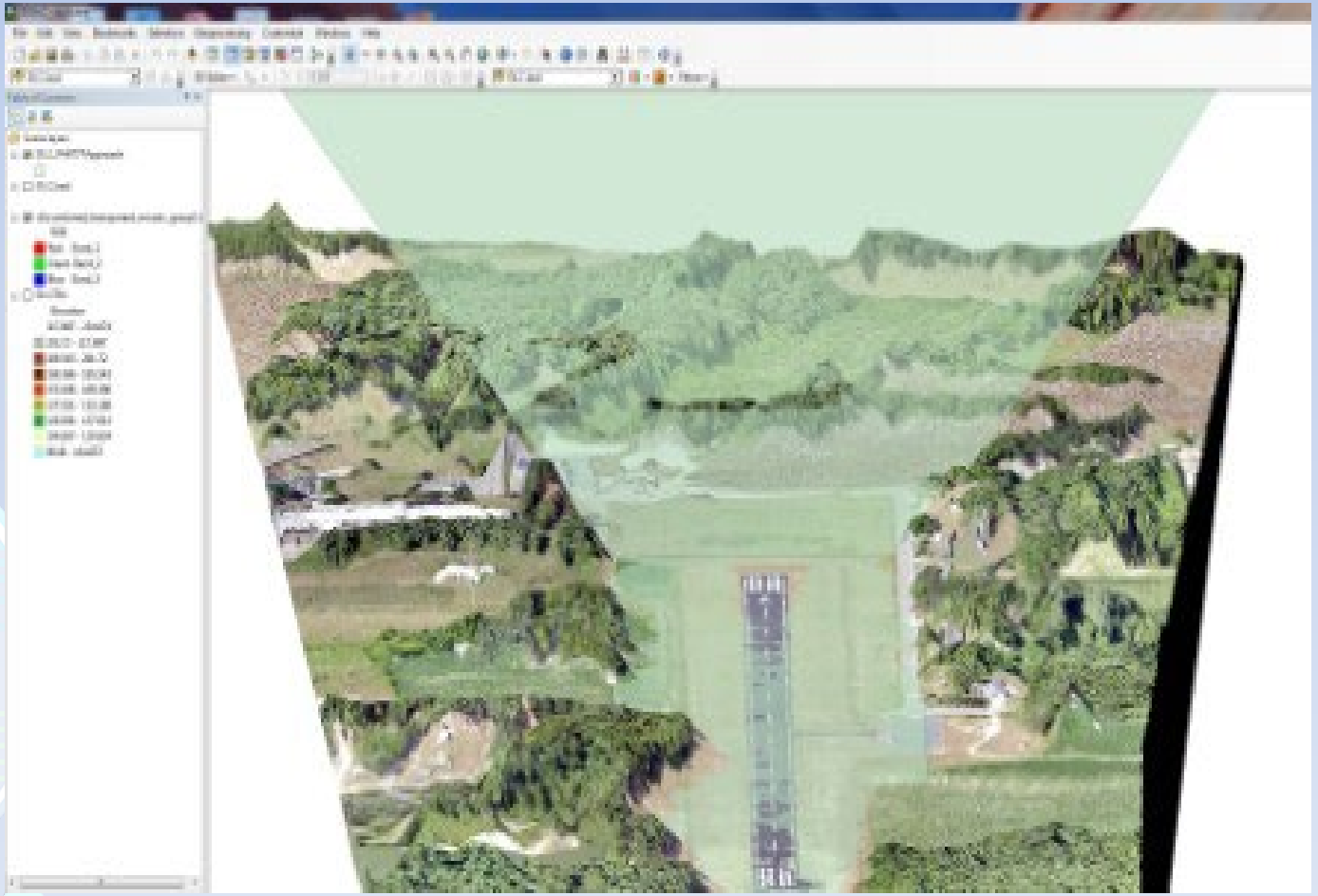
- Can not operate outside of Visual Line of Sight
- Battery life limitation
- Can only fly in VFR conditions
- Can not cover large areas in a single flight like conventional aerial data collection
- Limitation in heavily forested areas

SCAC UAS RESULTS

Point cloud imagery Dillon County Airport

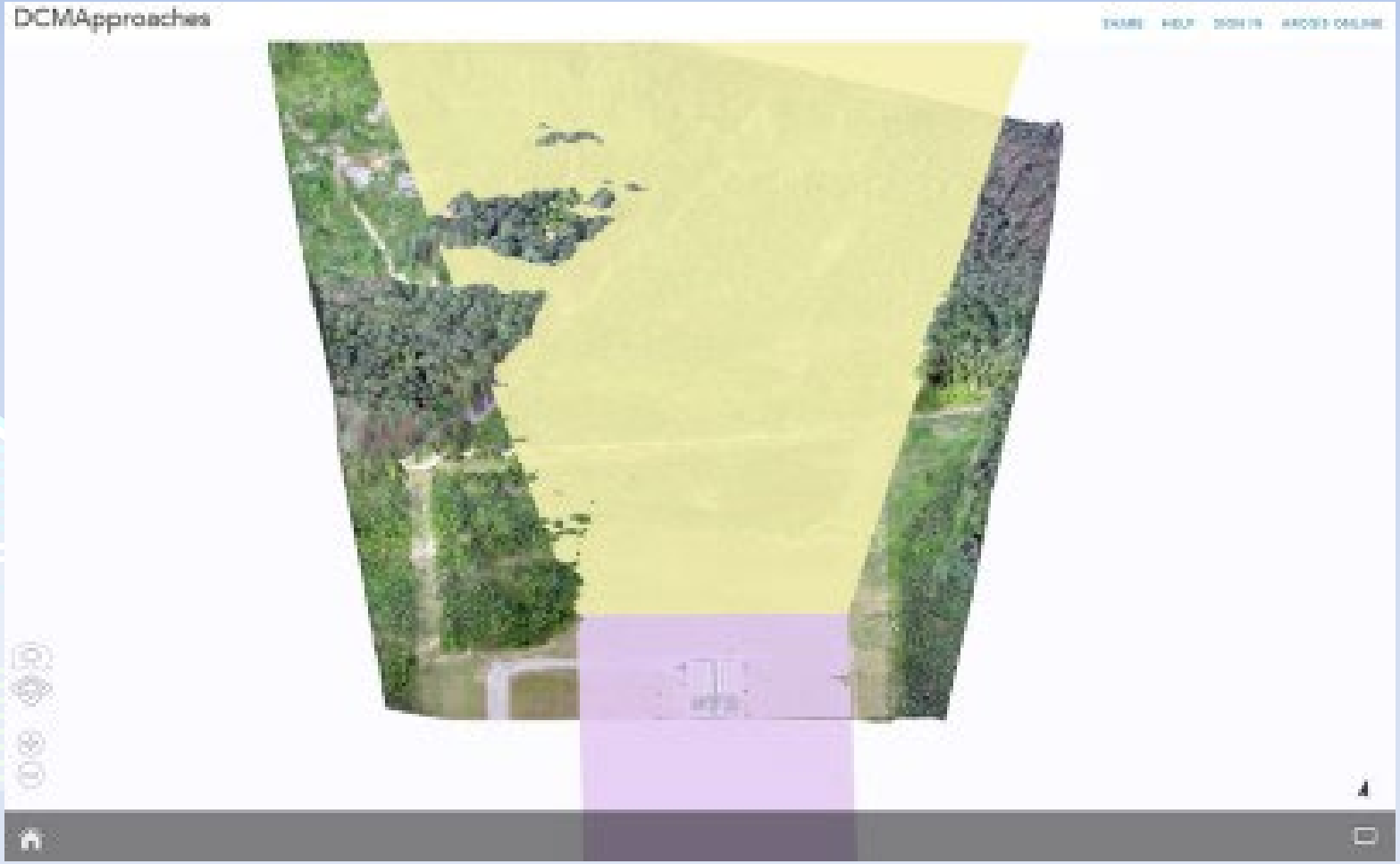
SCAC UAS RESULTS

Aerial image draped over point cloud



SCAC UAS RESULTS

Aerial image draped over point cloud



SCAC UAS RESULTS

Aerial image overlaid with property owner information

SCAC UAS RESULTS

A High Resolution aerial image

Analysis results format

- Interactive web application
- Hard copy map
- Map package to be given to others with access to ESRI ArcGIS
- Can be exported into AutoCad or any other mapping or engineering software that recognizes .tin models or .las files

Thank You

David Smith
dwsmith@aeronautics.sc.gov
803-896-6294

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May 30th, 2024

What is the FAASTeam?
Community Outreach and Public Perception of Drones

Joey Roberts - FAASTeam Drone Pro - CrossFlight Sky Solutions

Website: faasafety.gov | crossflightskysolutions.com
Twitter: @FAASafetyBrief
Instagram: @joey__213, @crossflightskysolutions
Facebook: FAADroneZone, CrossFlightSkySolutions
Linkedin: /joey-roberts

National FAA Safety Team (FAASTeam)

FAASTeam Organizational Structure

To fulfill its mission, the FAA's Safety Program is structured with a National FAA Safety Team (FAASTeam) staff with assigned personnel holding positions as Safety Liaison Team (SLT) Leads and FAASTeam Program Managers (FPM).

FAASTeam Process for Planning to Reduce Accidents

The National FAASTeam develops standardized safety interventions for General Aviation (GA), and may support other safety initiatives such as UAS, Next-Gen, Runway Safety and the General Aviation Joint Steering Committee (GAJSC) Safety Enhancements, etc. In addition, there is flexibility built into the program that affords the FPMs adequate flexibility to innovate locally, and respond to localized safety issues through:

- Accident/incident reports involving airmen from the area
- Hazards identified by FAA Inspectors at local Flight Standards District Offices
- Information from the local aviation community

FAASTeam Outreach

FAASTeam Representatives

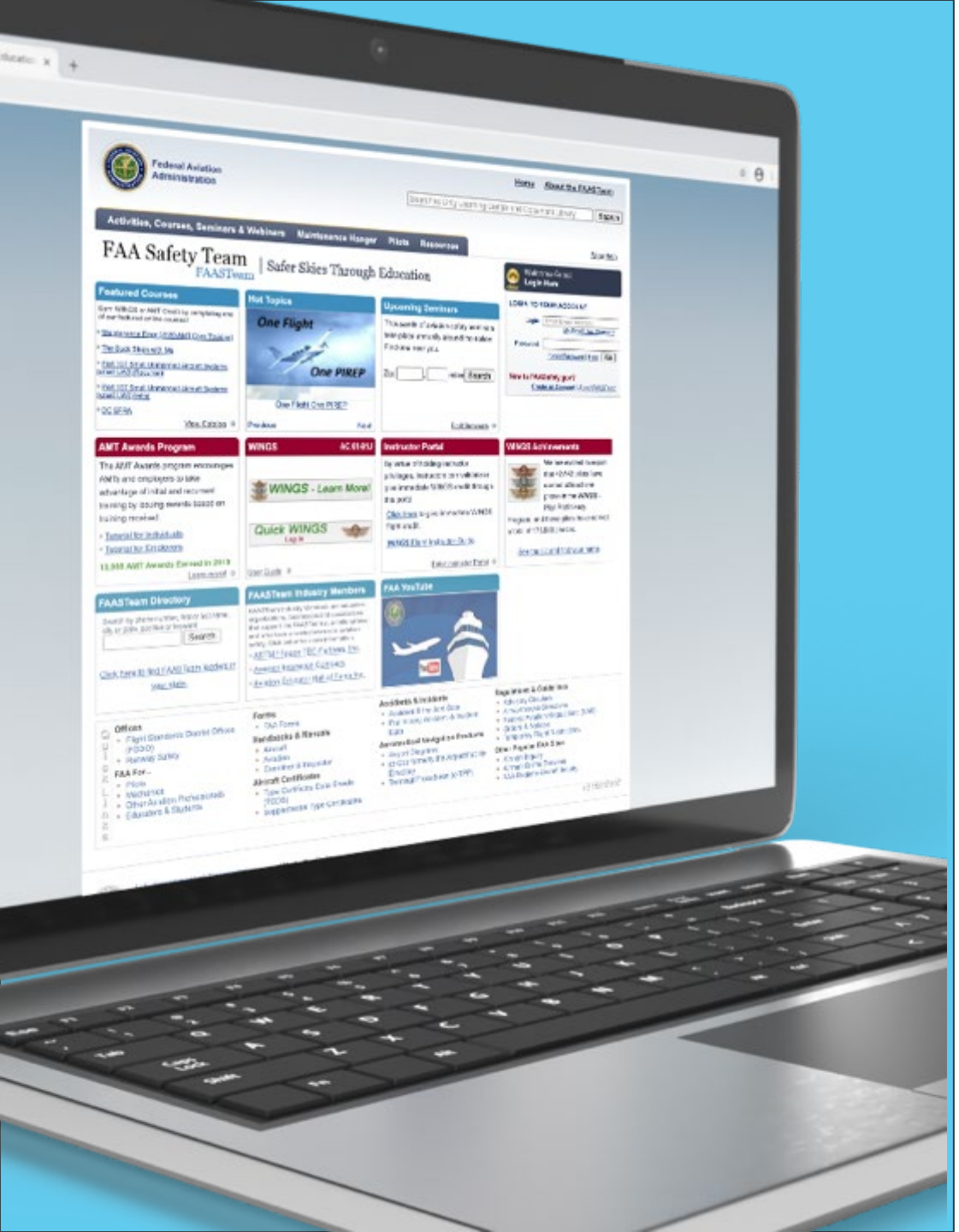
Aviation safety volunteers that wish to work closely with FAASTeam Program Managers (FPM) to promote safety may be designated as FAASTeam Representatives. Volunteers receive training and are supported by the FPM with equipment and materials.

FAASTeam Industry Members

The FAASTeam has guidelines for the establishment of Industry Members. They are companies or associations of people that have a stake in aviation safety. The guidelines describe how these groups and the FAASTeam can formalize their desires to promote aviation safety together.

FAASTeam Tools

FAASTeam program management is based on a safety risk management approach, using system safety principles, risk prioritization, and new technology concepts. These FAASTeam system safety techniques are used to shift the safety culture towards the reduction of accidents.



FAASTeam Outreach

➡ Relationships with the Aviation Community

- The FAASTeam "teams up" with individuals and the aviation industry to create a unified effort against accidents and "tip" the safety culture in the right direction.

➡ FAASTeam Members

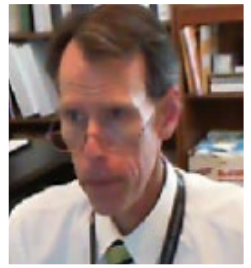
- A FAASTeam Member is anyone who makes a conscious effort to promote aviation safety and become part of the shift in safety culture.

To become a member:

- Sign-up at FAASafety.gov and take part in all it has to offer
- Pilots – participate in our new WINGS - Pilot Proficiency Program
- Mechanics– participate in the new automated AMT Awards Program
- Attend live FAASTeam webinars or events in your area

South Carolina FSDO 13 FAASTeam

Lanny Cline, FPM (OPS)



James Dangerfield, FPM (AW)

- 33 FAASTeam Representatives
- Seven FAASTeam Service Providers

Mission Statement

"Lower the Nation's aviation accident rate by conveying safety principles and practices through training, outreach, and education while establishing partnerships and encouraging the continual growth of a positive safety culture within the aviation community."

The SC FSDO FAASTeam Activity

FY 2023

Total Events (Seminar & Webinars): 141

Total Attendees: 7003

Average Attendance: 53

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Who can fly a drone?

Recreational Flyer and Modeler Community-Based Organization

Certificated Remote Pilot or Commercial Operator

Public Safety or Government User

Educational User

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Drones by the Numbers (as of 2/29/24)

781,781

Drones Registered

377,447

Remote Pilots Certified

375,226

Commercial Drones Registered

706,075

TRUST Certificates Issued

400,858

Recreational Drones Registered

5,697

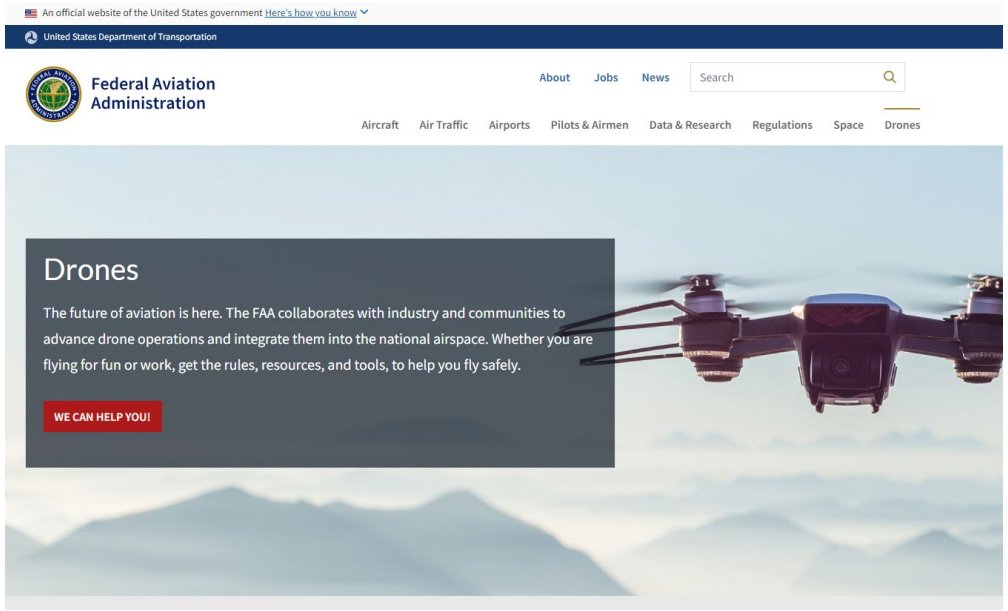
Paper Registrations

https://www.faa.gov/node/54496

FAA Drone Tools

- https://www.faa.gov/uas

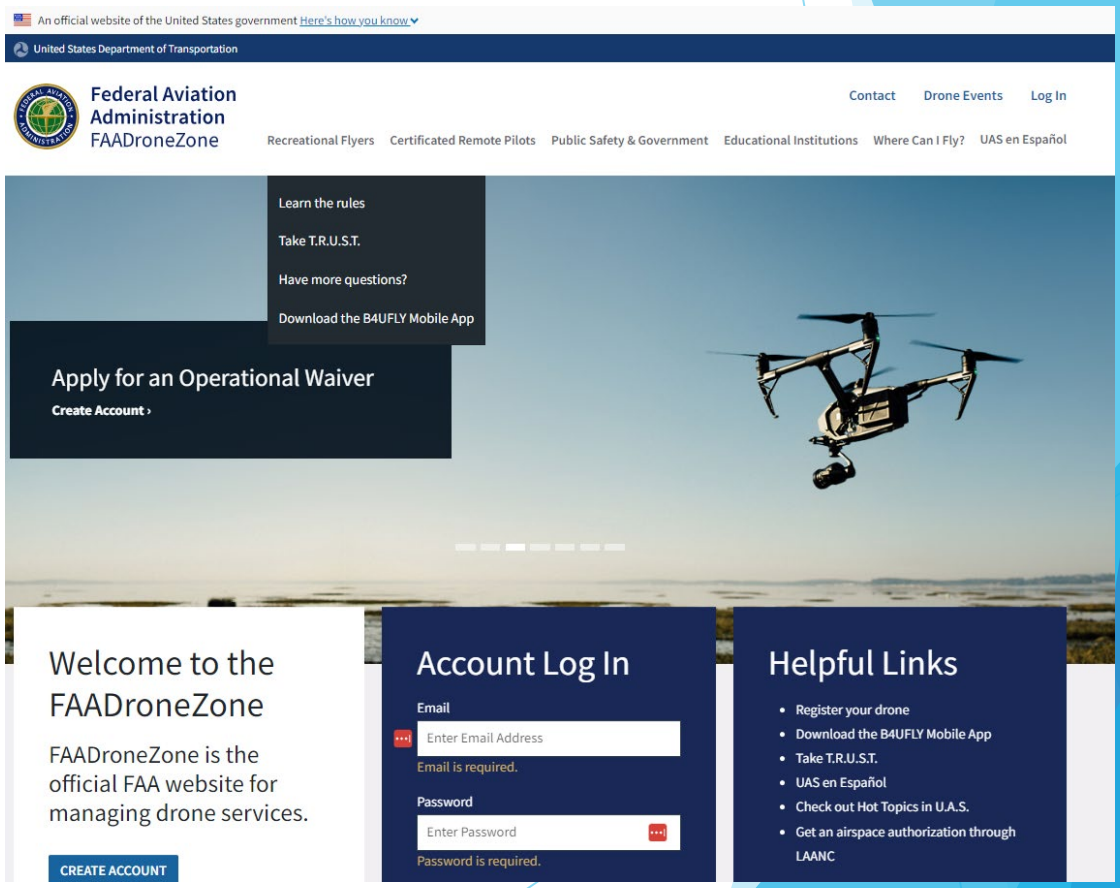
- What kind of drone flyer are you? https://www.faa.gov/uas/getting_started/user_identification_tool



FAA Drone Tools

- FAA Drone Zone
  - For authorizations, waivers, and registrations

https://faadronezone-access.faa.gov/



How can you get involved?

- Stay up to date with the latest events on FAAsafety.gov
- Participate in local area events
- Inform your community members of the rules and how to adhere to them
- Invite the FAASTeam to host events for your station/departement or community
- Join the FAASTeam

Thank you!

joeyr@crossflightskysolutions.com

Website: faasafety.gov | crossflightskysolutions.com
Twitter: @FAASafetyBrief
Instagram: @joey__213, @crossflightskysolutions
Facebook: FAADroneZone, CrossFlightSkySolutions
Linkedin: /joey-roberts

Networking Break

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drone simulator

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UNMANNED SOLUTIONS
airworxdrone.com

Panel Discussion

How Are State Agencies Using Drones

- Ryan Reid: Greenville County Sheriff's Office
- Scott Reynolds: Department of Health and Environmental Control
- Darryl Jones: SC Forestry Commission

Keynote Speaker

Cybersecurity Drone Policy Explained

- Casie Ocana: Director of AUVSI's Trusted Programs

AUVSI™

SCiDUC Symposium
May 30th, 2024

Unlocking Potential & Mitigating Risks: The Importance of Cybersecurity in UAS

Casie Ocańa
Director, Trusted Programs - AUVSI

Website: www.auvsi.org
Twitter: @AUVSI
LinkedIn: in/AUVSI

What We'll Uncover in This Session

- Threat Assessment – Is there really anything to worry about?
- Responses In Market
  - Blue UAS for DoD
  - Green UAS for non-DoD and commercial users
- Procurement Strategies for Compliance
- The Proper Pronunciation of My Name

The World's Critical Infrastructure Suffered 13 Cyber Attacks Every Second in 2023

Rising Threat Assessment: UAS

2017-2019

- **US Army** discontinues use of all DJI drones
- **CISA** releases threat memo on PRC drone risk
- **DHS** releases bulletin on PRC drone risk for critical infrastructure and ublicy safety
- **Congress** passes FY2020 NDAA prohibiting DoD from purchasing PRC drones

2020

- **DoJ bans** use of agency grants for purchasing PRC drones
- **DOI grounds** all PRC drones, noting cybersecurity risks
- **Dept of Commerce** places DJI on entity list and Dept of Treasury places DJI on Office of Foreign Assets Controls' list of firms part of military industrial complex

2021

- **Executive Order 139881** prohibits use of taxpayer dollars to procure UAS that present unacceptable risks and are manufactured by foreign adversaries
- DoD releases statement labeling DJI as posing potential threats to national security

2022

- **DoD** identifies DJI as Chinese military company
- **Congress** expands NDAA restrictions to also prohibit private companies working with DoD from using unsecure drones in performance of federal contract

2023

- **Congress** recommends Autel be added to Commerce Entity List
- **ASDA** is signed into law as part of the 2024 NDAA; extending DoD procurement ban on drones from covered entities to all US government agencies and prohibits federal agencies from operating these drones

2024

- **CISA & FBI** release updated warning memo on use of PRC drones in critical infrastructure operations
- **Sens. Thune & Warner** introduce DETECT Act, legislation directing NIST to develop procurement guidelines

The Risks – Tangible & Wide-ranging

Drone Data Security

Protect sensitive information from unauthorized access and safeguard privacy that could compromise both personal and national security.

Network Security

Robust network security for drones as connected devices is crucial to mitigate exposure risks and internal threats to organizational security

Operational Security

Reliance on firmware updates means that drone functionality is contingent on the manufacturer's continued support and updates

Protecting Against the Risks

Verification

Confirming cybersecurity and supply chain compliance for systems in advance, such as NDAA compliance when necessary

Risk Assessments

Operational reviews can help determine appropriate guidance

Ongoing training and policy updates can also minimize risks

DoD Compliance

The Blue UAS program makes commercial UAS available to **DoD and Federal Government** partners

Requirements for addition to the Blue List:

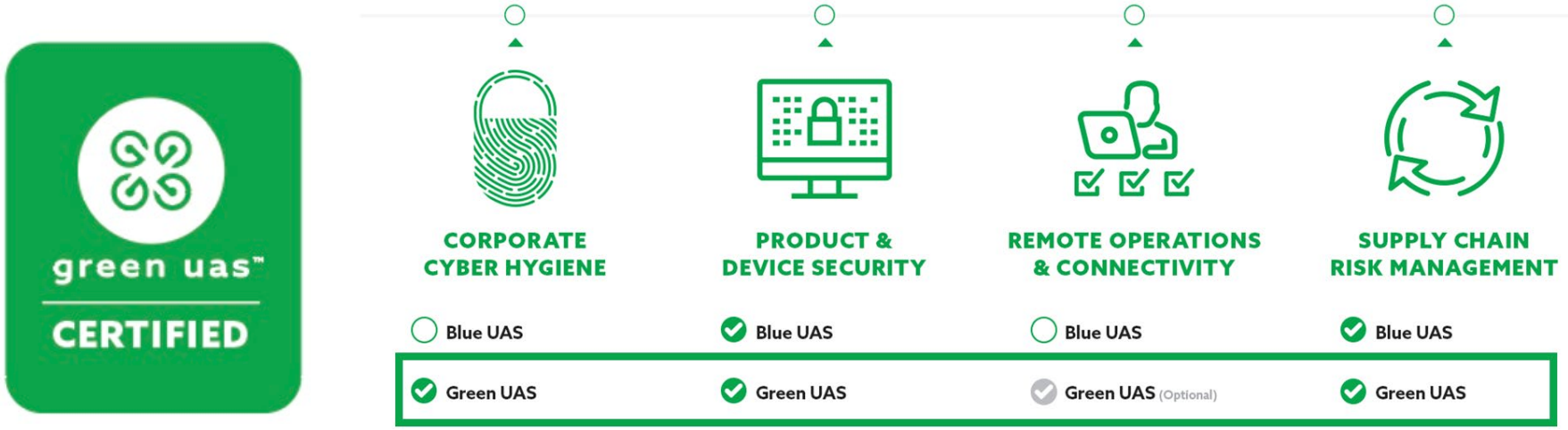
- A **DoD sponsor** with a bona fide operational or training need for the platform, defined as a DoD organization that is willing and able to fund the initial and ongoing platform NDAA compliance and cybersecurity testing, and intends to purchase the platform upon addition.

- It offers a new capability or meets a need in a way not previously done.

- It is not duplicative or have significant overlap with platforms already available.

Policy compliant commercial UAS, once vetted by the Blue UAS On-Ramp effort, do not require an Exception to Policy (ETP), reducing the administrative burden on end users.

Expanding Compliance with Green UAS



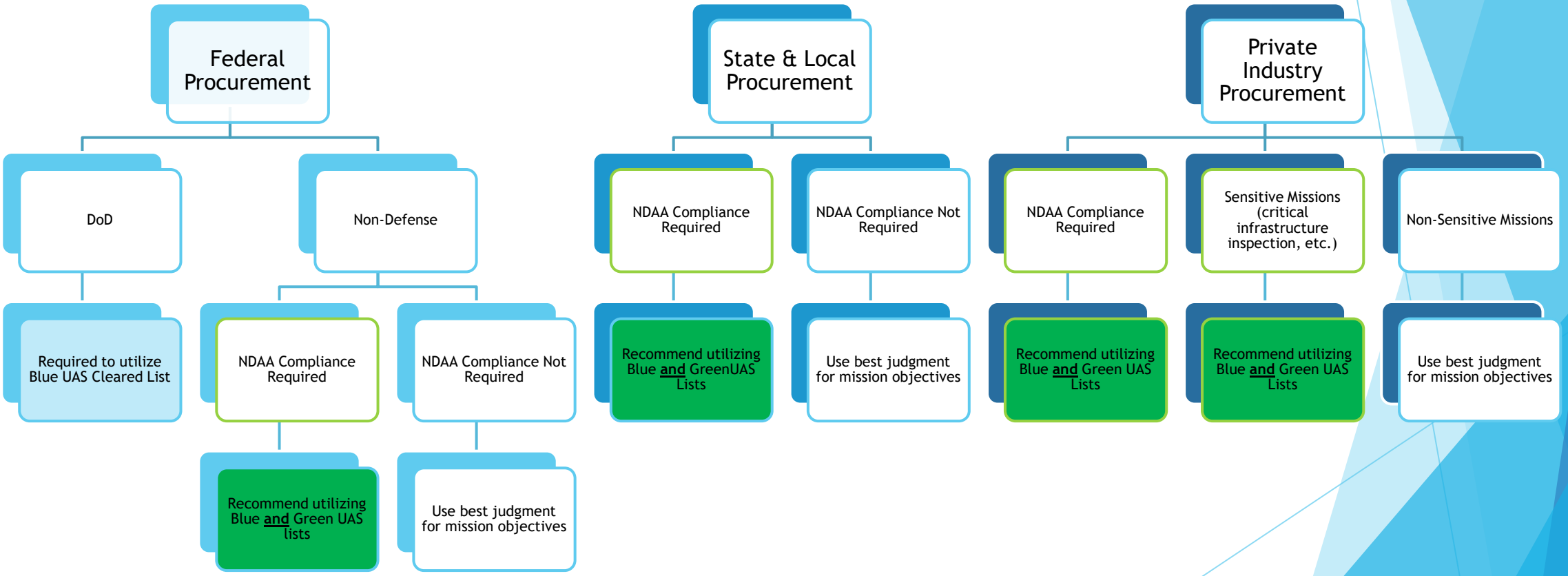
Green UAS was designed to support the **expansion of DIU's Blue UAS** with vetted drones that meet the same level of cyber security and supply chain requirements as mandated by Congress in the 2020 and 2022 NDAAs;

and to provide a **non-DoD government and commercial pathway** to ensure trust in drone security, using robust frameworks and additional areas of assessment not included in Blue UAS, and framework flexibility based on customer demands

Verification Cheat Sheet

Consideration	DIU | BlueUAS	AUVSI | GreenUAS
Focus	DoD Certified Solutions	Commercial and Non-Defense Certification
Application Process	Requires a DoD Sponsor	Open to all
NDAA Compliance	Provides NDAA Compliance Verification	Provides NDAA Compliance Verification
GSA Inclusion	Yes	Not yet
Remote Operations & Connectivity	Out of scope for certification	Verified during certification
Corporate Cyber Hygiene	Out of scope for certification	Verified during certification
Product & Device Security	Verified during certification	Verified during certification
Supply Chain Risk Management	Verified during certification	Verified during certification

Key Takeaways:
Cybersecure Procurement Strategies



Thank You!

Lunch

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EM
airworxdrone.com

Bentley Industry & Innovation Overview - SCiDUC

Michael Barkasi

Solutions Engineer| May “24”

Bentley®

Bentley

For over 40 years, Bentley has served the engineers and other professionals responsible for designing, constructing, and operating sustainable infrastructure essential to the quality of life for everyone, everywhere.

WHO WE ARE

We are more than a software company. We are partners dedicated to advancing the world's infrastructure.

WHAT WE DO

We provide infrastructure professionals with the software and support they need to make this world a better place.

WHY WE DO IT

We know that better infrastructure means a better economy, a better environment, and a better quality of life for all.

Bentley®

The Infrastructure Engineering Software Company

Bentley Systems | **Industries**

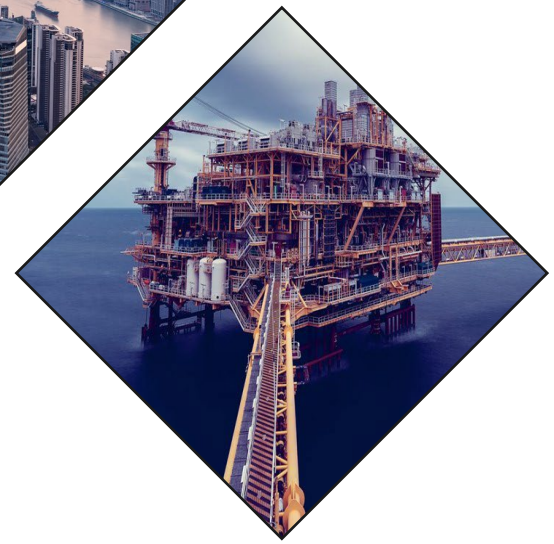
Data

Transportation

Cities

Energy

Water



Analysis

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Bentley Systems | **Infrastructure Lifecycle**

Operation & Maintenance

- Manage inventory and schedule maintenance
- Integrate IoT for condition assessment
- Monitor in real-time and analyze data
- Create virtual replicas of assets
- Predictive maintenance and reduction of site visits

Planning

- Utilize reality data for digital context
- Optimize coordination with stakeholders
- Assess existing conditions thoroughly
- Visualize designs effectively
- Manage risks and understand financial impacts early

Construction

- Ensure regulatory compliance
- Enhance worker safety measures
- Utilize virtual assessment and documentation for assets
- Virtual construction environments with clash detection
- Coordinate and communicate with stakeholders

Design

- Speed up project completion
- Minimize design revisions and rework
- Lower project risks, costs, and delays
- Establish a unified design and analysis platform
- Enhance real-time collaboration through digital twins

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Transportation
Bentley

Bentley Systems | **Transportation Solutions**

- Road Design, Engineering, and Construction
- Rail Engineering and Construction
- Tunnel Design and Analysis
- Bridge Design, Engineering, and Construction
- Bridge Monitoring

Bentley

Bentley System | **Transportation Offerings**

Operation & Maintenance

- iTwin Experience
- iTwin IoT
- iTwin Capture
- AssetWise Reliability
- AssetWise ALIM
- AssetWise 4D Analytics
- PlantSight

Planning

- iTwin Capture
- iTwin Experience
- OpenRoads ConceptStation
- Orbits 3DM
- CUBE, Emme, Dyname
- ProjectWise

- ProjectWise
- SYNCHRO
- OpenRoads Designer
- OpenTunnel Designer
- OpenBuildings Designer
- OpenRail Designer
- Overhead Line Designer
- OpenBridge Designer
- OpenBridge Modeler
- ProConcrete
- MicroStation

Design

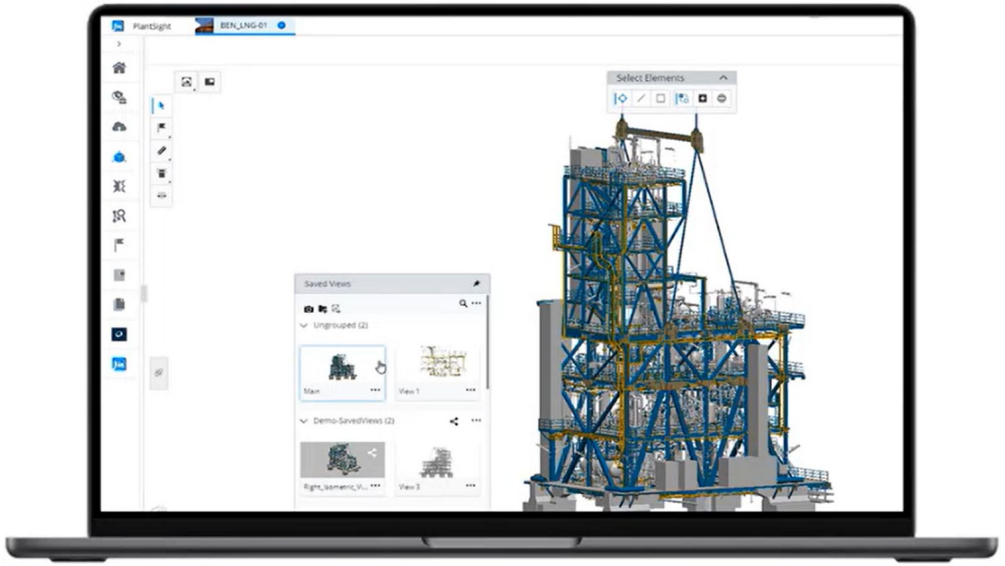
- ProjectWise
- SYNCHRO Control
- SYNCHRO 4D
- SYNCHRO Field

Construction

Bentley


Energy
Bentley

Bentley Systems | **Energy Benefits**



- Instant data access for stakeholders
- Collaboration between Owners and Contractors
- Centralize project data for full visibility
- Integrate data to minimize project risks
- Streamline design-to-construction handoff

Bentley

Bentley System | **Energy Offerings**

Operation & Maintenance

- iTwin Experience
- iTwin IoT
- iTwin Capture
- AssetWise Reliability
- AssetWise ALIM
- AssetWise 4D Analytics
- PlantSight

Planning

- iTwin Capture
- iTwin Experience
- PlantSightOpenPlant
- iTwin Experience
- OpenUtilities Designer
- OpenUtilities Substation
- PlantSight
- ProjectWise

- ProjectWise
- Seequent
- SACS
- MOSES
- SACS Fatigue
- SACS Collapse
- SACS Pile Structure Design
- SACS Offshore Structure
- PLAXIS 3D
- PLAXIS Monopile Designer
- LeapfrogOpenWindPower
- OpenWindPower Cloud Services
- OpenWindPower Floating Platform

Design

- ProjectWise
- iTwin Capture
- iTwin Experience
- Bentley Infrastructure Cloud
- SYNCHRO Field
- SYNCHRO Control
- SYNCHRO Perform
- SYNCHRO 4D

Construction

Bentley

Bentley System | **Electric Utility Offerings**

Operation & Maintenance

- iTwin Experience
- iTwin IoT
- iTwin Capture
- iTwin Capture Manage & Extract
- AssetWise Reliability
- AssetWise ALIM
- AssetWise 4D Analytics

Planning

- iTwin Experience
- iTwin Capture
- PLS-GRID
- PLS-CADD
- SPIDAcalc
- SPIDAsilk

- ProjectWise
- SYNCHRO Field
- SYNCHRO Control
- SYNCHRO Perform
- SYNCHRO 4D
- PLS-CADD
- PLS-GRID

Construction

- ProjectWise
- PLS-CADD
- PLS-GRID
- PLS-POLE
- PLS-TOWER
- MicroStation
- SPIDAcalc
- SPIDAsilk
- SPIDAstudio
- ProStructures
- LumenRT
- OpenBuildings
- OpenUtilities Substation
- OpenUtilities Designer

Design

Bentley


Water
Bentley

Bentley System | **Water Infrastructure Offerings**

Operation & Maintenance

- iTwin IoT
- iTwin Capture
- iTwin Experience
- PlantSight
- AssetWise Reliability
- AssetWise 4D Analytics
- AssetWise ALIM

Planning

- iTwin Experience
- iTwin Capture
- MicroStation
- OpenFlows WaterGEMS
- OpenFlows WaterSight
- ProjectWise

- ProjectWise
- OpenPlant
- PlantSight
- OpenBuildings
- OpenRoads
- OpenFlows WaterSight
- OpenFlows WaterGEMS
- OpenFlows HAMMER
- OpenFlows SewerGEMS
- OpenFlows FLOOD
- MicroStation
- LumenRT
- PLAXIS
- ADINA

Design

- ProjectWise
- SYNCHRO Field
- SYNCHRO Control
- SYNCHRO Perform
- SYNCHRO 4D

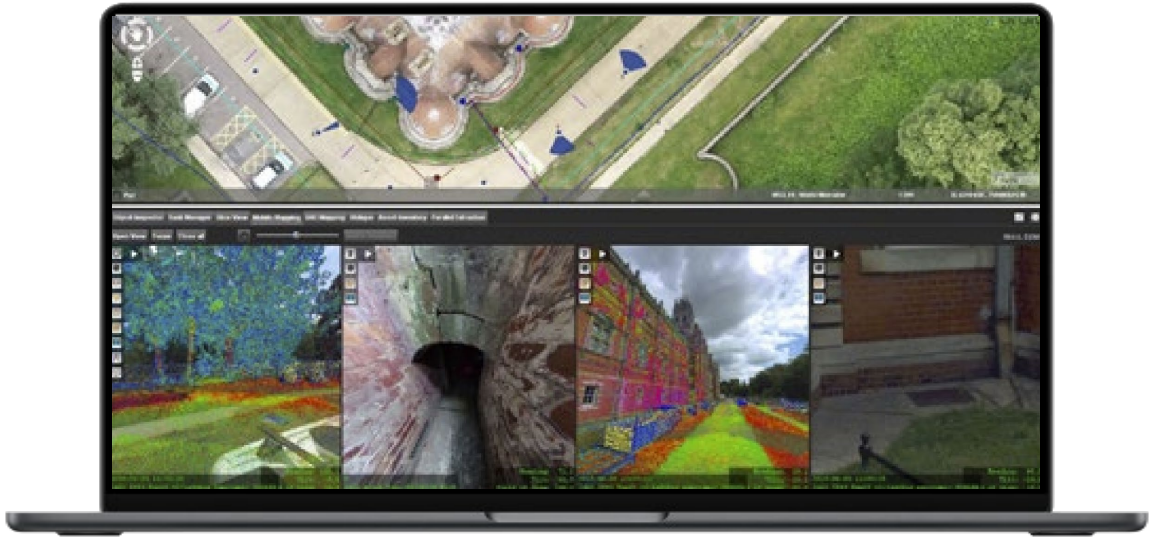
Construction

Bentley


Cities
Bentley

Bentley Systems | **Cities & Campuses Benefits**

- Real-time spatial insight for assets
- Gain the visibility and insight needed to improve decision-making and business outcomes.
- Data-driven decisions across all stakeholders
- Connect data, streamline workflows, and enhance asset performance.
- Oversee data from various sources, formats, scales, or complexities—including point clouds, reality and BIM models, and operational data from business systems and IoT-connected devices



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Bentley Systems | **Cities & Campuses Infrastructure**

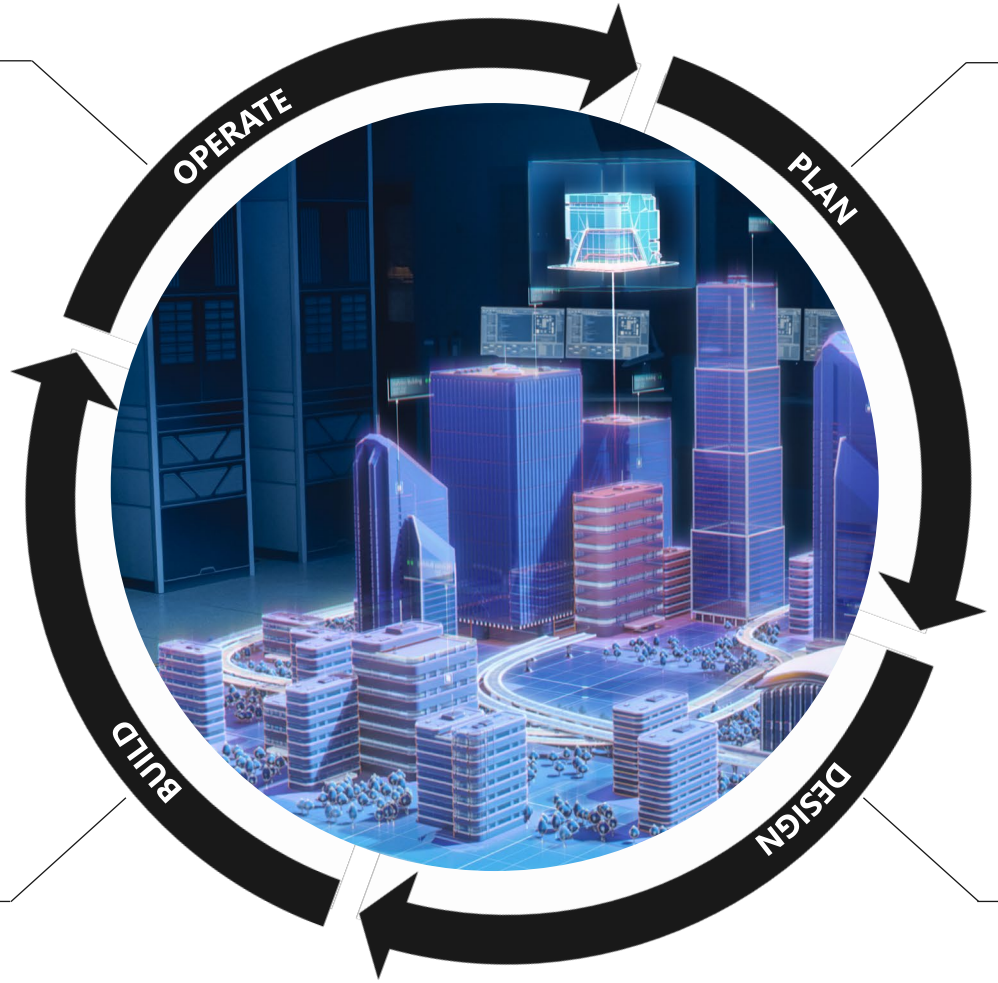
- Digital Twin Integrations
- Building Design & Analysis
- Real-Time Visualization
- Steel and Concrete Design
- Visual Integration Platform
- Airport Planning & Coordination

Bentley

Bentley System | **Cities Solution Capabilities**

Operation & Maintenance

- iTwin Experience
- iTwin IoT
- iTwin Capture
- AssetWise Reliability
- AssetWise ALIM
- AssetWise 4D Analytics
- PlantSight



Planning

- MicroStation
- OpenCities Planner
- LEGION
- SYNCHRO

- ProjectWise
- SYNCHRO
- OpenBuildings Designer
OpenSite Designer
- Civil WorkSuite
- ProStructures
- ITwin Capture Modeler
- ITwin Capture Manage & Extract
- OpenCities Planner
- Microstation
- CUBE, LEGION, EMME, Dynameq
- Federated Data Environment (Digital Twin)
- Geographic Information System (GIS)

Design

- ProjectWise
- SYNCHRO Control
- SYNCHRO 4D
- SYNCHRO Field

Construction

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Bentley’s Focus On Innovation

Through Infrastructure Digital Twins

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Digital Twin

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A **digital twin** is a virtual representation of real-world entities and processes, synchronized at a specified frequency and fidelity.

An **iTwin** is an **infrastructure digital twin** implemented using Bentley's iTwin Platform and product portfolio.

Infrastructure Digital Twin

Connect disparate data and systems

Reduce costs and better decision-making

Streamline processes and workflows

Improve collaboration and transparency

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Embracing and exceeding open standards

Bentley

Digital Twins

Linked Visualizations & Data

Capture Modeler | Capture Modeler Center

iTwin Capture Modeler

Master / Engine installed together

Optionally a Second Capture Modeler (lic required) can be networked

Cloud Console

iTwin Capture Modeler Center

- Modeler Center architecture allows for licensing of Master / Engines
- No Limitation on the number that can be networked together

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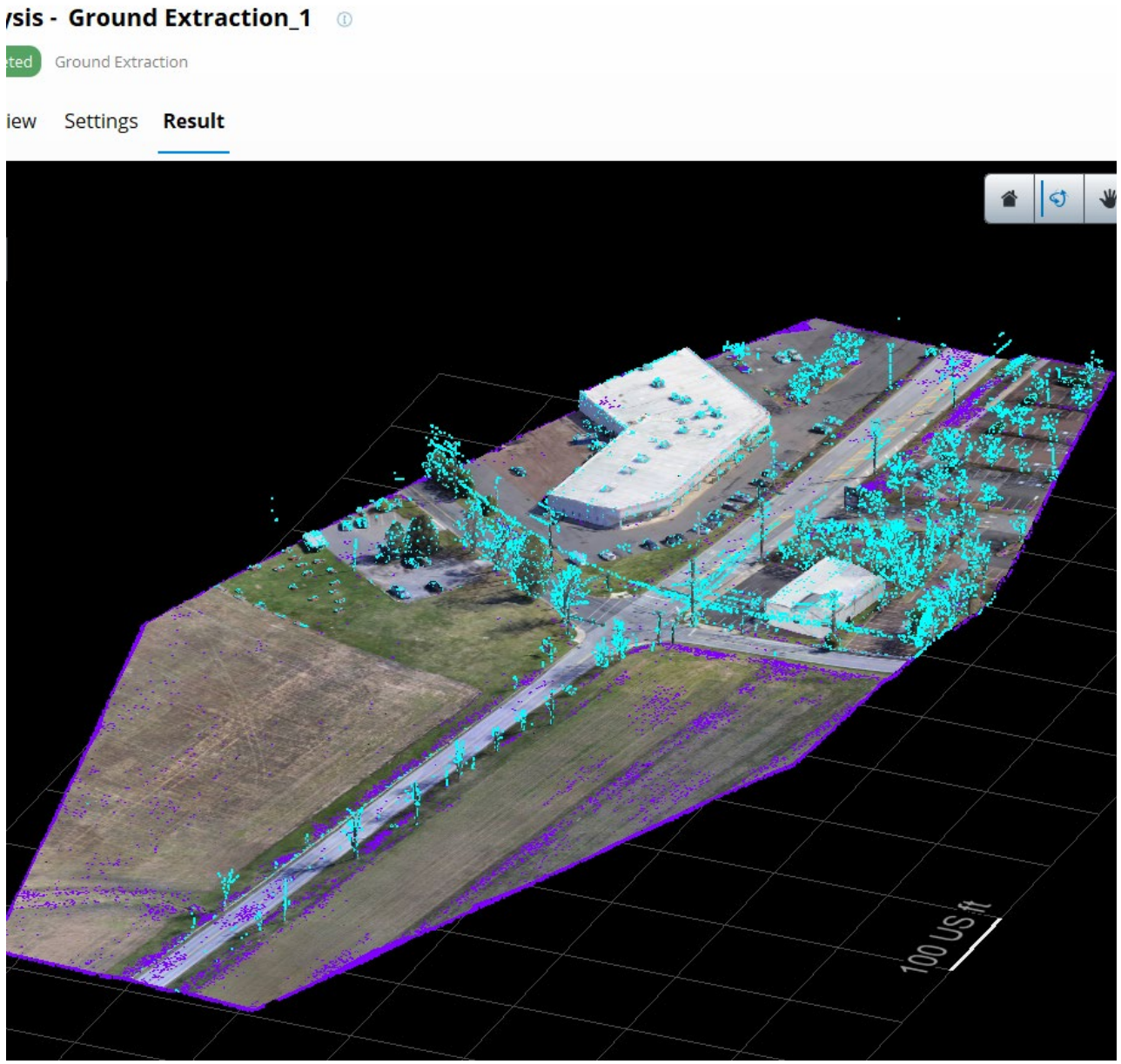
Reality Modeling

Capturing existing conditions in **3D using one or a combination of devices** (UAVs, Handheld Camera, Laser Scanner) to support different applications such as **Digital Twins**, **Mapping, Design, Construction, Inspection** and **Asset Management**

AI Ground Detection

- **iTwinCapture Modeler**
Reality Model to classified point cloud

- **OpenRoads Designer**
Classified point cloud to Terrain Model



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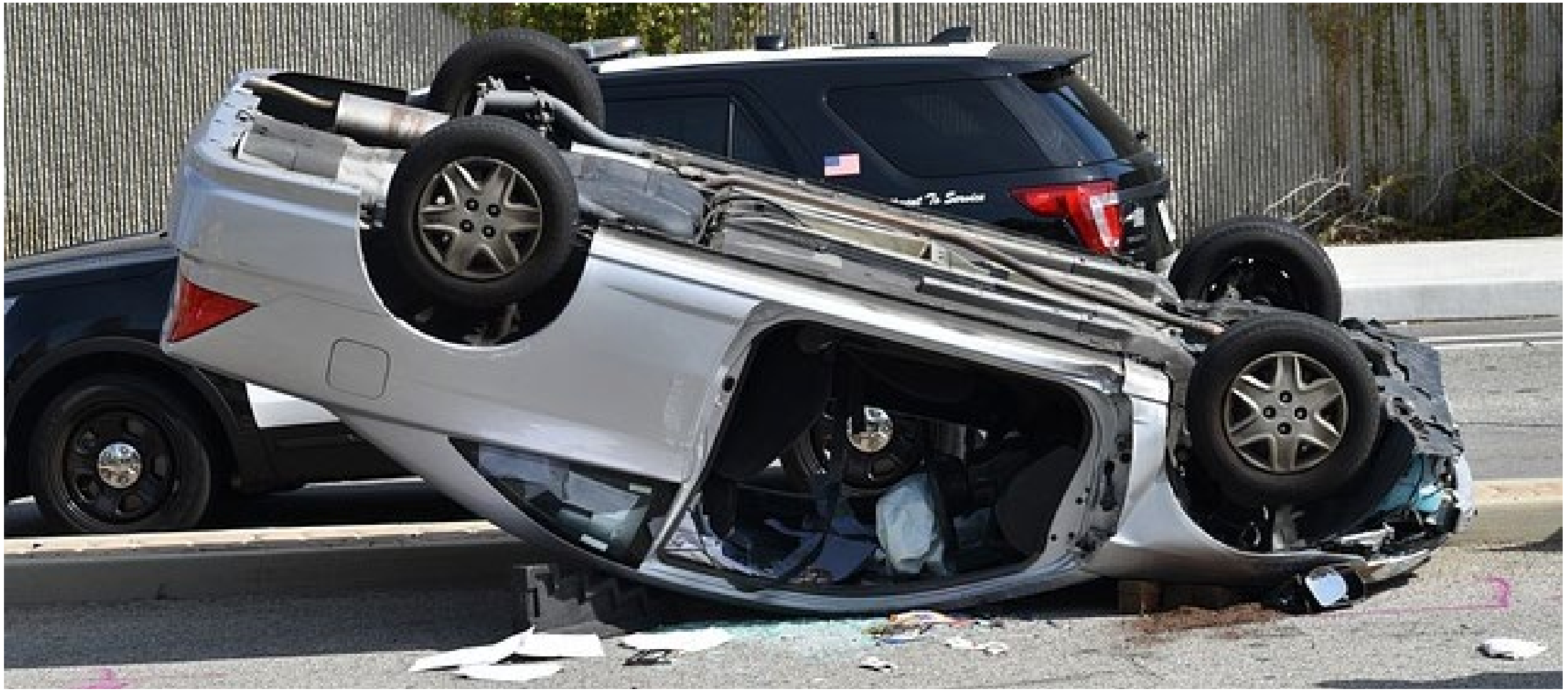
4D Simulation

Earthwork – 4D

Bentley

Forensics



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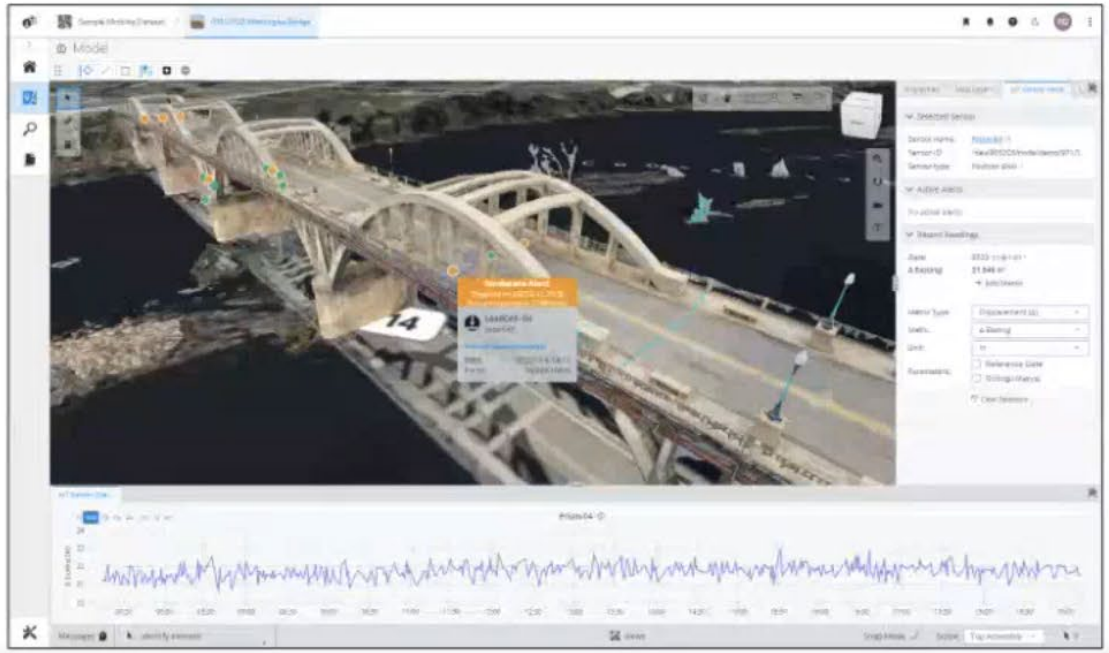
iTwin IoT

iTwin IoT is a cloud-based, scalable monitoring platform for infrastructure professionals that provides real time data insights through active condition monitoring for natural and built environments.



Capabilities

- Remotely monitor, analyze, and manage all instrumentation systems and IoT sensor data
- Measure structural movement
- Perform condition assessment and help detect and prevent damage using current and historical data
- Enables data centricity throughout all phases of the project lifecycle via digital twin integration
- Open interoperability with no vendor lock-in

News

- Improved analysis capabilities within the digital twin through convergence of sensor data with the unification of Enterprise Data Historian and File Source data
- Real-time data and historical IoT time series data access with a revised sensor data service API, freeing users to focus on innovation vs. data wrangling
- AI/ML workflows leveraging existing IoT time series data streams to improve user analytical reasoning and decision-making

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Academic Lightning Talks

- Dr. Joe Mari Maja of South Carolina State University
  - RFID and Drones for Nursery Inventory Management
- Wayne McFee of the National Oceanic and Atmospheric Administration (NOAA)
  - Uncrewed Aircraft Systems in Marine Mammal Research
- Dr. Nikos Vitzilaios of the University of South Carolina
  - Aerial Drones for Water Sensing and Targeted Sampling
- Mike Proud of the National Weather Service
  - Drones and Weather - Important Forecast Elements for Drone Pilots

SCiDUC Symposium
May 30th, 2024

SCiDUC
SC INTERAGENCY DRONE USERS CONSORTIUM

Drones at Work: Innovating Inventory Tracking and Management

Joe Mari Maja, Ph.D., MBA

Website: https://www.scsu.edu/faculty/joe_mari_maja.php
www.iad4sc.com

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Center of Applied Artificial Intelligence for Sustainable Agriculture

Joe Mari J. Maja, Ph.D.
Senior Researcher & Director

Van Patiluna, M.Eng.
Senior Researcher

Hemanth Dakshimaurthy, Ph.D.
Research Scientist

Graduate Students
Jyoti Neupane, Aashish Karki

Previous Students/Interns
Megan Abenina, Stewart Bell, Adam Ellie, Matthew Polak, Jake Enloe, Alex Steedley, Jakob Weber, Christina Lewis, Sihang Han, Colby Heirs

Visiting Scientists
Ana de Castro Mejias, Institute for Sustainable Agriculture, Spain
Jose Pena Barragan, Institute of Agricultural Sciences, Spain
Jan Behmann – Institut fur Nutzpflanzenwissenschaften und Ressourcenschutz*, Germany
David Bohnenkamp – Institut fur Nutzpflanzenwissenschaften und Ressourcenschutz*, Germany

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CAAI4SA
Center of Applied Artificial Intelligence for Sustainable Agriculture
1890 Research and Extension, Public Service and Agriculture
South Carolina State University
making agriculture more equitable

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USDA
United States Department of Agriculture
National Institute of Food and Agriculture

SOUTHERN EXTENSION RISK MANAGEMENT EDUCATION

NASA

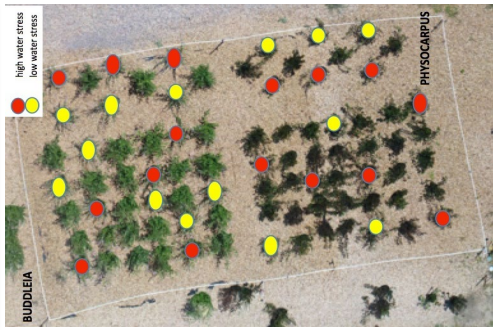
SCDA
SOUTH CAROLINA DEPARTMENT OF AGRICULTURE
1879

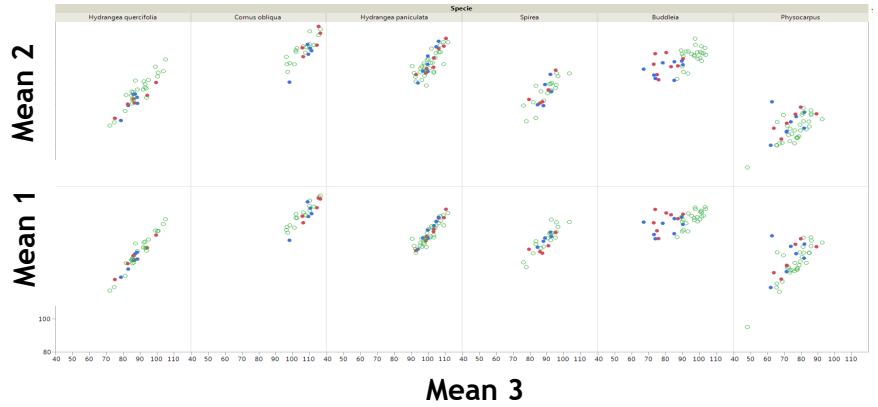
Horticultural Research Institute
The AmericanHort Foundation

Cotton Incorporated

Research

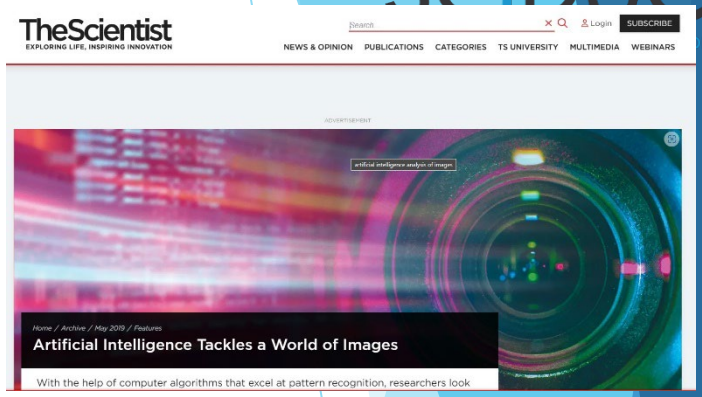
UAV Projects: Detect water stress in ornamental plants using sUAS-imagery





Canon ELPH 130 IS

MAPIR 2 Survey



- *Featured at The Scientist Magazine.*

Ana I. de Castro, **Joe Mari Maja**, Jim Owen, James Robbins, Jose M. Pena. 2018. Experimental approach to detect water stress in ornamental plants using sUAS-imagery, Proc. SPIE 10664, Autonomous Air and Ground Sensing Systems for Agricultural Optimization and Phenotyping III, 106640N (21 May 2018); https://doi.org/10.1117/12.2304739

Freeman, D.; Gupta, S.; Smith, D.H.; **Maja, J.M.**; Robbins, J.; Owen, J.S., Jr.; Peña, J.M.; de Castro, A.I. **Watson on the Farm: Using Cloud-Based Artificial Intelligence to Identify Early Indicators of Water Stress**. Remote Sens. 2019, 11, 2645. https://doi.org/10.3390/rs11222645

Research

UAV Projects: Detecting water stress with hyperspectral data

INRES

UNIVERSITÄT BONN

UofA DIVISION OF AGRICULTURE RESEARCH & EXTENSION University of Arkansas System

USDA United States Department of Agriculture National Institute of Food and Agriculture

VT VIRGINIA TECH

SCState PUBLIC SERVICE & AGRICULTURE Innovate. Educate. Elevate.

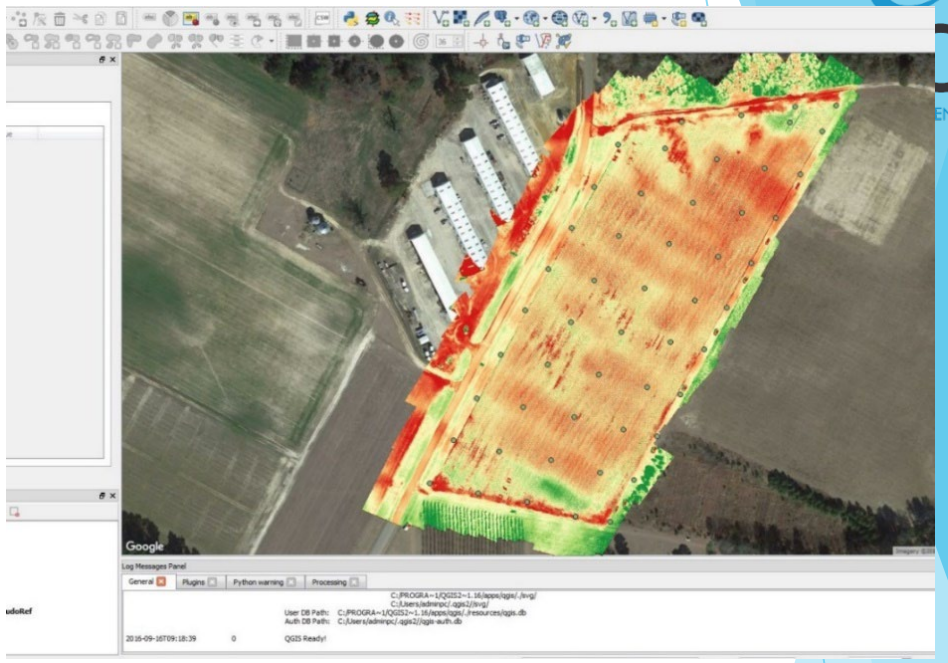
Borra-Serrano, I., Pena, J.M., Maja, J.M., Owen, J., Robbins, J., De Castro, A.I. 2023. Evaluation of a low-cost drone sensor to discriminate water stress levels in ornamental plants. 14th European Conference on Precision Agriculture (ECPA 2023), July 2-6, 2023, Bologna, Italy.

Research

NIR & RGB Camera

COA# 2014-ESA-155-COA
N-538XC

- Yield estimate
- Insect abundance and crop injury
- Phenotyping



TUTORIALS

1. QGIS - Georeferencing
1.1 Addendum to QGIS Georeferencing
2. QGIS - NDVI
3. QGIS - Digitizing UAV Image

Maja, JMM*, T. Campbell, J. Camargo Neto, P. Astillo. 2016. Predicting cotton yield of small field plots in a cotton breeding program using UAV imagery data, , Proc. SPIE 9866, Autonomous Air and Ground Sensing Systems for Agricultural Optimization and Phenotyping, 98660C (May 17, 2016); https://doi.org/10.1117/12.2228929

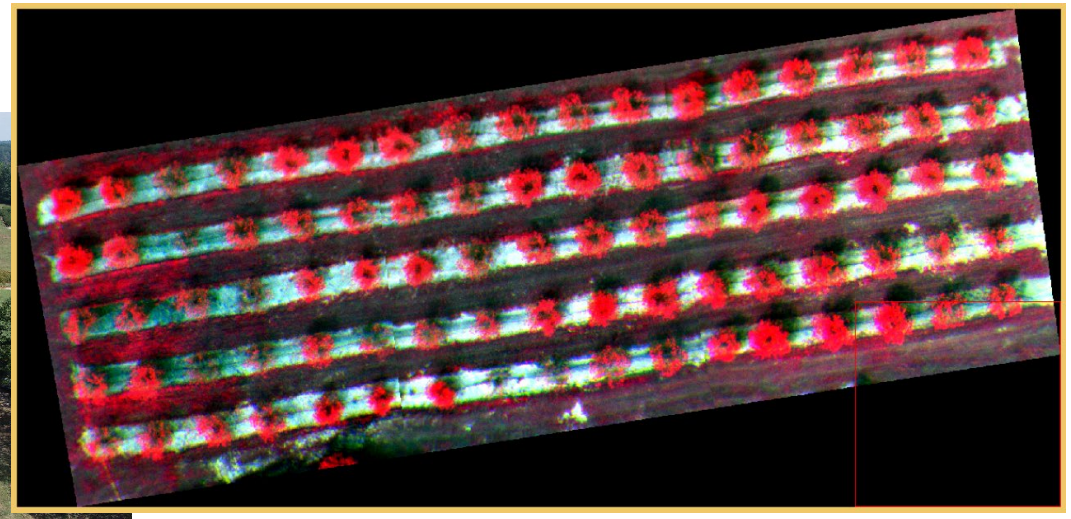
Fact Sheet

•Features to consider when purchasing a small UAS **here**
•Pilot Certification and Aircraft Registration for non-hobby users of Small Unmanned Aircraft Systems here
•Significant Timeline Events for Small Unmanned Aircraft Systems here

J. Frank Schmidt Foundation Grant

Research

UAV Projects: Drone-based hyperspectral monitoring of peach tree defoliation caused by leaf rust disease



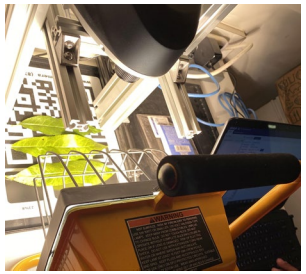
Collaborators:

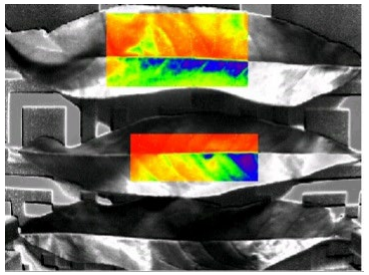
José M. Peña, Juan Carlos Melgar, Guido Schnabel, Ana I. de Castro

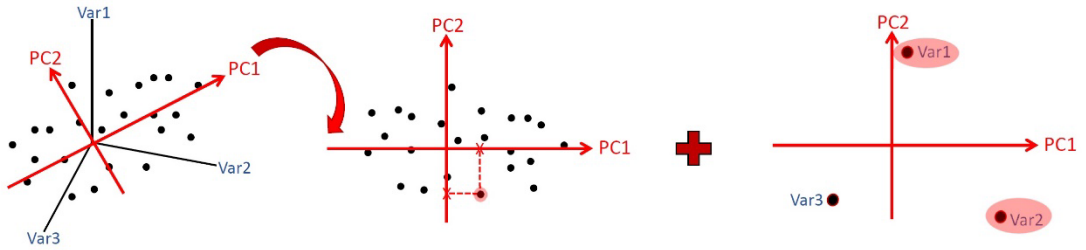
de Castro, A, Melgar, JC., Maja, J.M., Schnabel, G., Dorado, J., Lopez-Granados, F., Pena, J. 2022. Digitalizacion en cultivo de melocotonero: Caso practico en EE UU. Agricultura Journal.

Research

Prediction of Potassium in Peach Leaves Using Hyperspectral Imaging

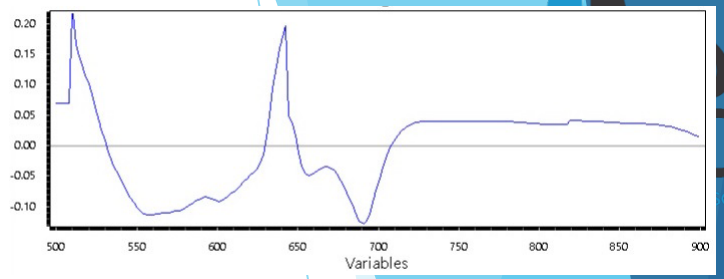




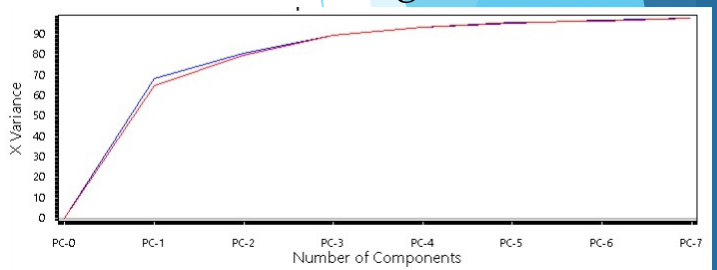


Trees	PC-1	PC-2	
H1-T1	68%	12%	80%
H1-T2	48%	23%	71%
H1-T3	69%	12%	81%

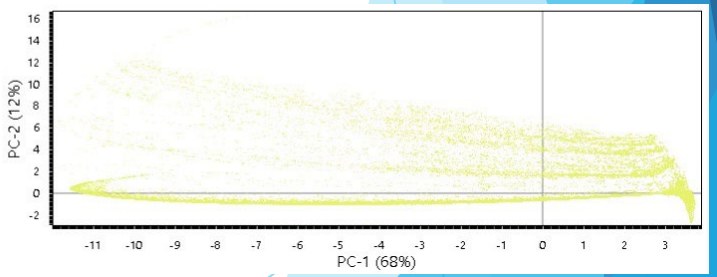
Trees	Band 1	Band 2	Band 3	Band 4
H1-T1	500 - 520	630 - 640	550	690
H1-T2	500- 520	630 - 640	550	690
H1-T3	500 - 520	630 - 640	550	690



Loadings



Explained Variance



Scores

Abenina, M.I.A.; **Maja, J.M.**; Cutulle, M.; Melgar, J.C.; Liu, H. Prediction of Potassium in Peach Leaves Using Hyperspectral Imaging and Multivariate Analysis. AgriEngineering 2022, 4, 400-413. https://doi.org/10.3390/agriengineering4020027

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Research

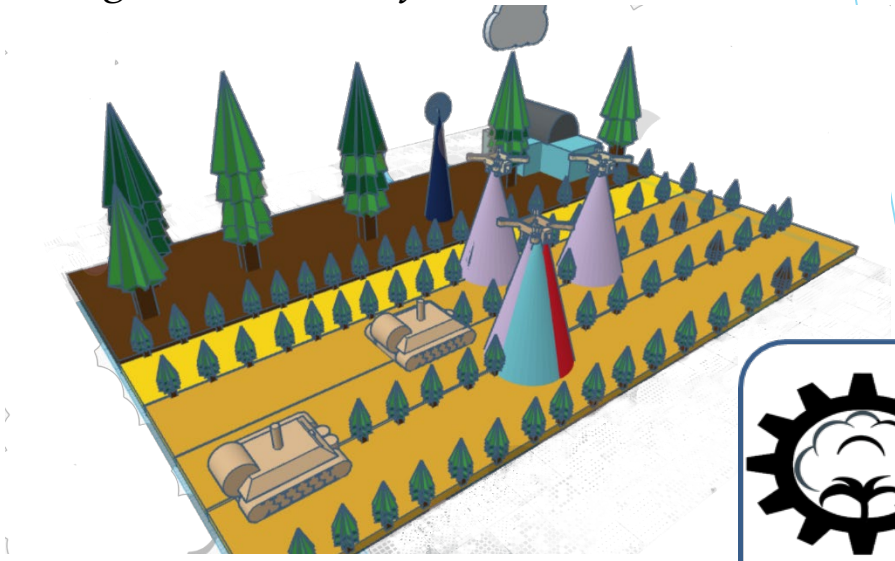
Robots for Cotton Production

Farmers pick cotton in Korla City, Bayingolin Mongolian Autonomous Prefecture

Efficiency of farming ~ economies of scale

John Deere Cotton Harvester

proof of concept



Cotton Harvesting Autonomous Prototype

100% organic

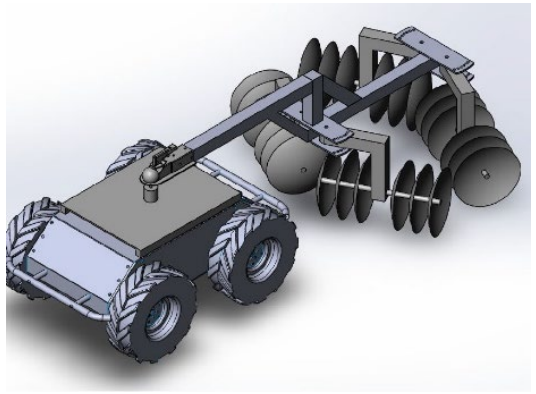
Barnes E, Morgan G, Hake K, Devine J, Kurtz R, Ibendahl G, Sharda A, Rains G, Snider J, **Maja JM**, Thomasson JA, Lu Y, Gharakhani H, Griffin J, Kimura E, Hardin R, Raper T, Young S, Fue K, Pelletier M, Wanjura J, Holt G. Opportunities for Robotic Systems and Automation in Cotton Production. AgriEngineering. 2021; 3(2):339-362. https://doi.org/10.3390/agriengineering3020023

Maja, J.M.; Polak, M.; Burce, M.E.; Barnes, E. CHAP: Cotton-Harvesting Autonomous Platform. AgriEngineering 2021, 3, 199-217. https://doi.org/10.3390/agriengineering3020013

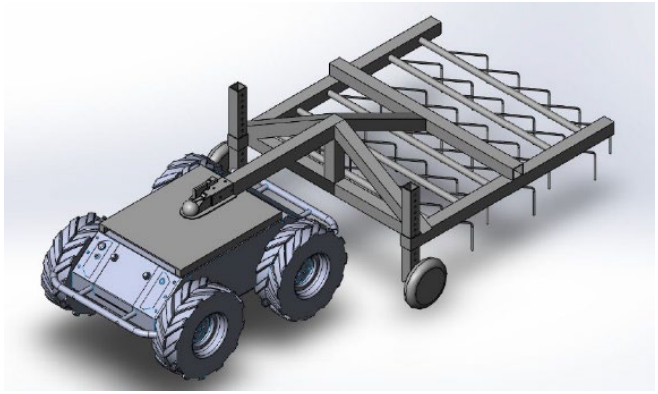
Mail, M.F.; **Maja, J.M.;** Marshall, M.; Cutulle, M.; Miller, G.; Barnes, E. Agricultural Harvesting Robot Concept Design and System Components: A Review. AgriEngineering 2023, 5, 777-800. https://doi.org/10.3390/agriengineering5020048

Research

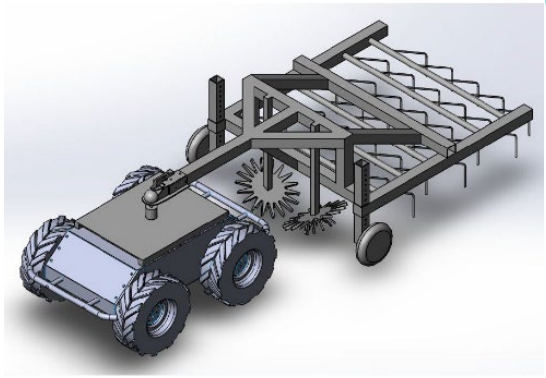
Robots for Cotton Production



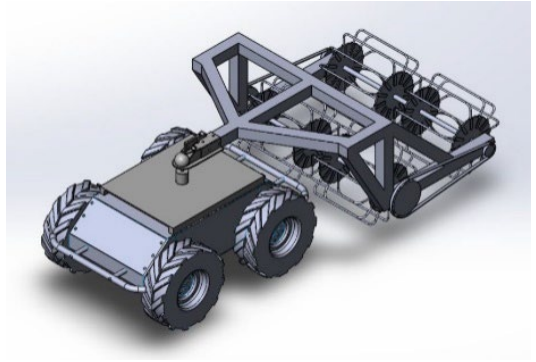
Adjustable Harrow Disk



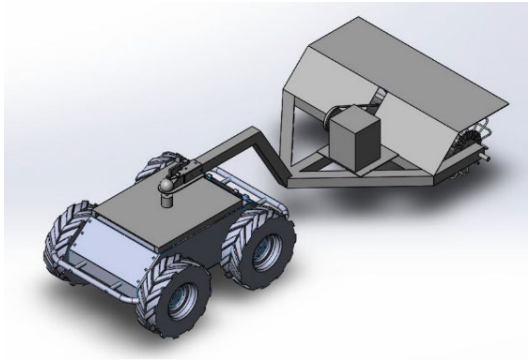
Flex Tine



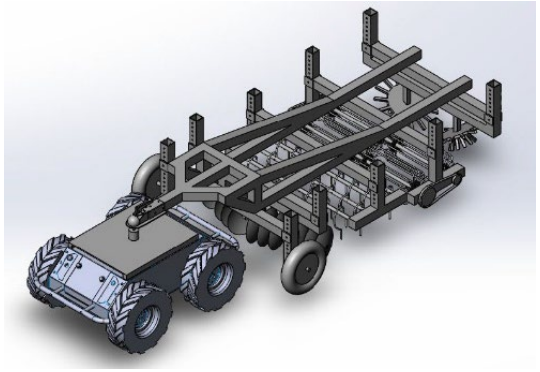
Finger Flex Tine



Basket



Motor-driven Basket



Modular Weeder

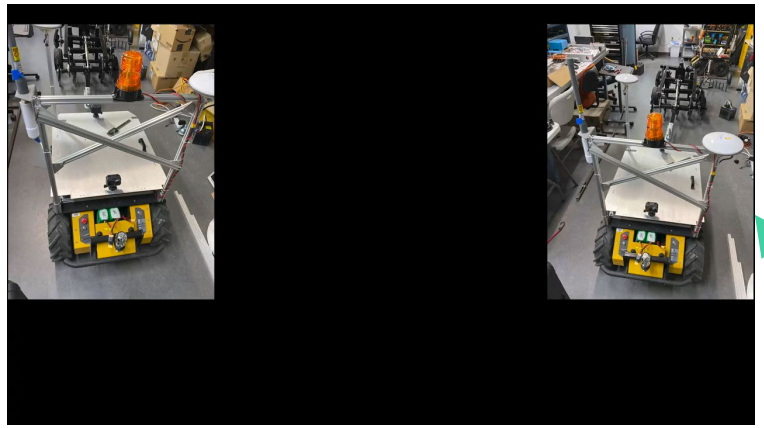
Cutulle, M.A., **Maja, J.M.** 2021. Determining the utility of an unmanned ground vehicle for weed control in special crop systems. Italian Journal of Agronomy 2021, Vol. 16:1865, https://doi.org/10.4081/ija.2021.1865

Maja, J.M.*; Cutulle, M. γ; Barnes, E. γ; Enloe, J.; Weber, J. 2021. Mobile Robot Weeder Prototype for Cotton Production, AgEng 2021 Conference, Evora Portugal, July 4-8, 2021.

Maja, J.M.*; Polak, M. [a]; Burce, M.E. [a]; Barnes, E [γ]. 2021. CHAP: Cotton-Harvesting Autonomous Platform. AgriEngineering. 2021; 3(2):199-217. https://doi.org/10.3390/agriengineering3020013

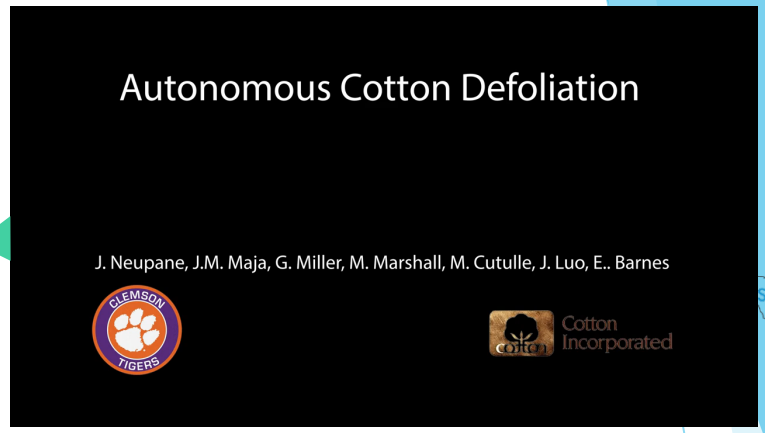
Research

Robots for Cotton Production

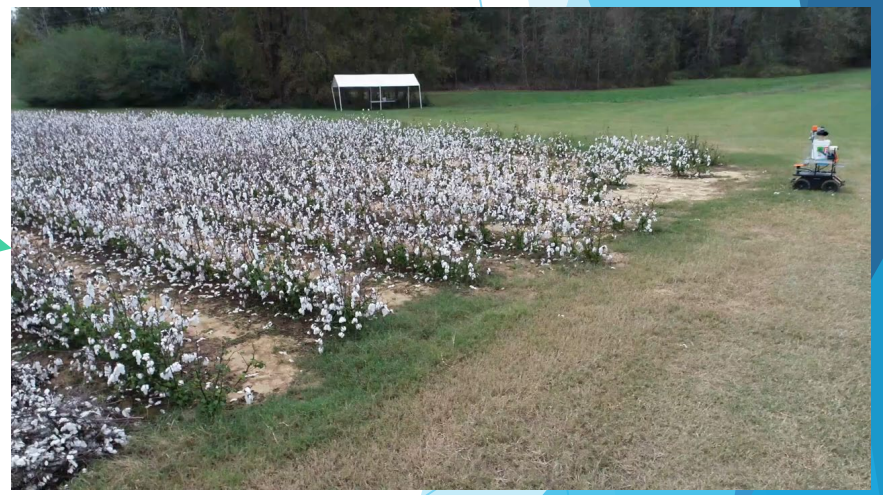


Weeder

Cultivator



Sprayer



Harvester

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Research

Using RFID, and Drones to Improve Plant Inventory

To demonstrate merging specific ground- and aerial-based technologies (aerial-based unmanned systems; RFID; BLE) in a whole system approach to address the specific need of providing on-demand plant inventory

Patiluna, V.; Maja, J.M.; Robbins, J. Evaluation of Radio Frequency Identification Power and Unmanned Aerial Vehicle Altitude in Plant Inventory Applications. AgriEngineering 2024, 6, 1319-1334. https://doi.org/10.3390/agriengineering6020076

Quino, J.; Maja, J.M.; Robbins, J.; Owen, J., Jr.; Chappell, M.; Camargo, J.N.; Fernandez, R.T. The Relationship between Drone Speed and the Number of Flights in RFID Tag Reading for Plant Inventory. Drones 2022, 6, 2. https://doi.org/10.3390/drones6010002

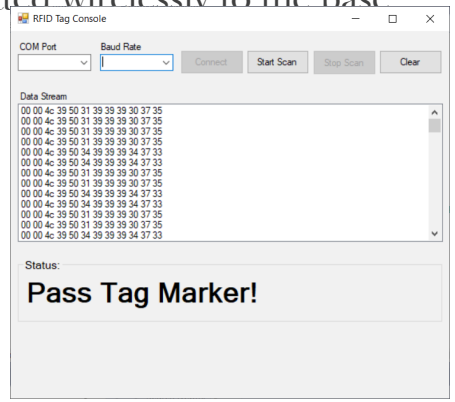
Quino, J.; Maja, J.M.; Robbins, J.; Fernandez, R.T.; Owen, J.S., Jr.; Chappell, M. RFID and Drones: The Next Generation of Plant Inventory. AgriEngineering 2021, 3, 168-181. https://doi.org/10.3390/agriengineering3020011

Research

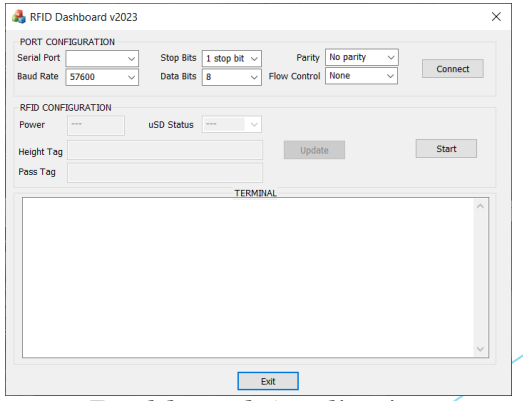
Using RFID, and Drones to Improve Plant Inventory

- UAV: DJI Matrice 600 Pro
- RFID-RM: ATSAM3X8E microcontroller + M6E-NANO RFID Module chip + microSD card writer/reader (for storing RFID data) + xBee transceiver
- Reader Antenna: RP-TNC UHF antenna (860-960 MHz)
- Payload weight: 360 grams
- Dashboard application was developed to control the RFID power setting and log the read tags in addition to the microSD card.
- RFID power setting can be adjusted at 15 dBm, 20 dBm and maximum of 27 dBm.
- Another application was developed to monitor the 'pass' and 'height' marker tags.
- Data from RFID-RM was transmitted wirelessly to the base computer via xBee.

RFID-RM and antenna suspended under the Matrice 600 Pro UAV.



Marker tags monitor



Dashboard Application

Base computer with two xBee transceiver.

Research

Using RFID, and Drones to Improve Plant Inventory

2022: 9,000 RFID Tags were deployed at Dudley Nursery

2023: 80 RFID Tags were deployed at Dudley Nursery

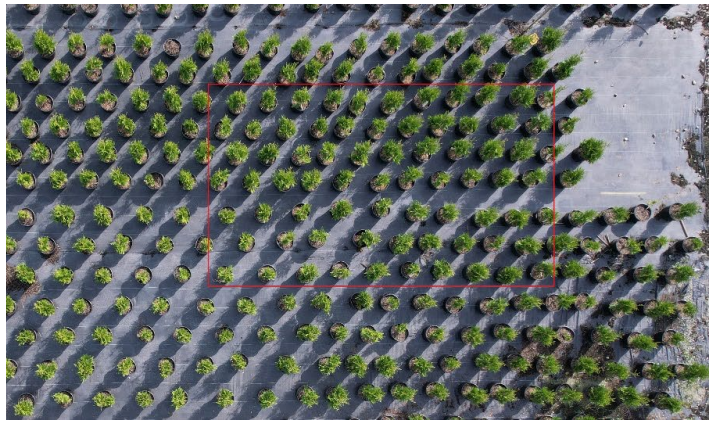
Tag Type	Antenna	Attachment
L5	dog bone	stake
L6	dog bone	loop-lock
L8	square wave	stake
L9	square wave	loop-lock

- A total of 20 tags per type spread across the two plots.
- Each plot included a total of 40 tags, with 10 tags of each type.
- Tags were placed randomly within each plot.
- L8 tags are used as ‘pass’ and ‘height’ markers.
- All the tags were manufactured and supplied by Avery Denison Corporation.

Passive RFID tags used.

Research

Using RFID, and Drones to Improve Plant Inventory

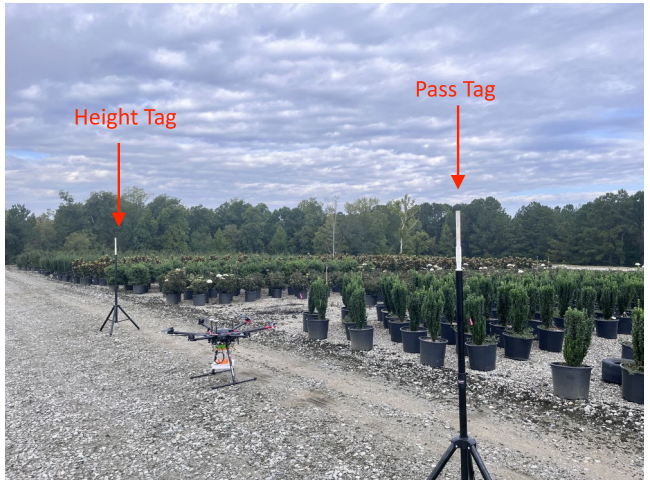


Aerial view of study plot.

L9		L6		L9		L6		L8		L5		L9		L9		L9		L8				P
	X		X		X		X		X		X		X		X		X		X			
L6		L8		L8		L6		L8		L5		L6		L8		L8		L8				
	X		X		X		X		X		X		X		X		X		X			
L5		L6		L6		L5		L5		L6		L6		L9		L8		L8				
	X		X		X		X		X		X		X		X		X		X			
L5		L6		L5		L5		L9		L9		L9		L5		L9		L9				H

RID tags assignment map.

- Plots W7 and W10 have similar layouts.
- Tag assignments are determined randomly per plot.
- Experiments were conducted at Dudley Nurseries in Thomson, GA, USA (33.52242, -82.51449).
- Two plots provided with different plants.
  - *Thuja X 'Green Giant' (plot W7)*
  - *Ilex crenata 'Sky Pencil' (plot W10)*



Marker tag positions.

Satellite view of plots W7 and W10.

Thuja X 'Green Giant' Ilex crenata 'Sky Pencil'

Research

Using RFID, and Drones to Improve Plant Inventory

- A total of 3 take-off and land cycles (one for each UAV power setting).
- Before the first take-off, the tags are validated using a handheld scanner (Zebra RFD8500) to ensure all the tags are accounted for.
- Two passes will be made per the RFID power setting.
- During tag scanning, UAV will fly in a U-shape pattern over the study plot.

RFID power setting	UAV altitude	Flight Status
15 dBm	3 m	**take-off** - scan tags - scan pass tag - scan tags – scan height tag
	5 m	scan tags - scan pass tag - scan tags – scan height tag
	7 m	scan tags - scan pass tag - scan tags – scan height tag - **land**
20 dBm	3 m	**take-off** - scan tags - scan pass tag - scan tags – scan height tag
	5 m	scan tags - scan pass tag - scan tags – scan height tag
	7 m	scan tags - scan pass tag - scan tags – scan height tag - **land**
27 dBm	3 m	**take-off** - scan tags - scan pass tag - scan tags – scan height tag
	5 m	scan tags - scan pass tag - scan tags – scan height tag
	7 m	scan tags - scan pass tag - scan tags – scan height tag - **land**

UAV flight plan.

Research

Using RFID, and Drones to Improve Plant Inventory

UAV approaching ‘pass’ tag.

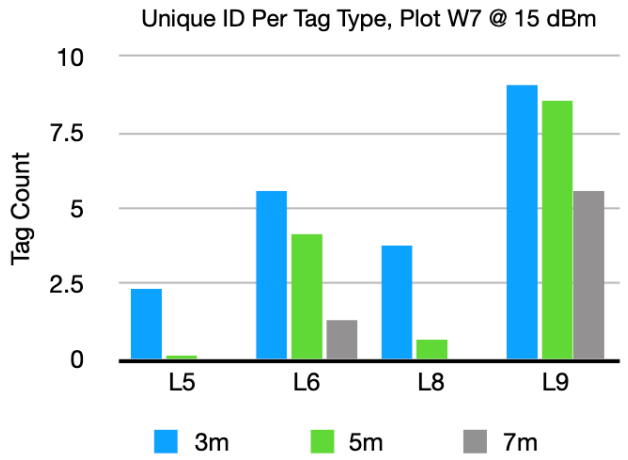
UAV in flight.

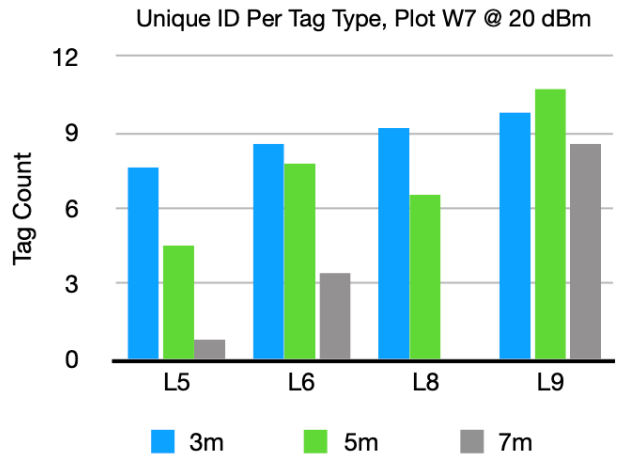
Research

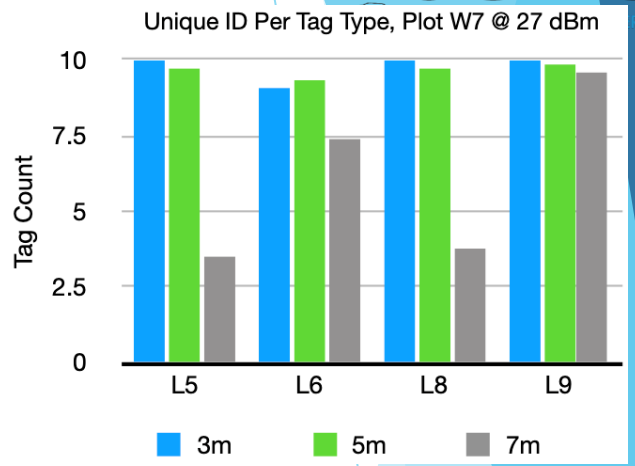
Using RFID, and Drones to Improve Plant Inventory

Unique Tags Detected Per Type (average)

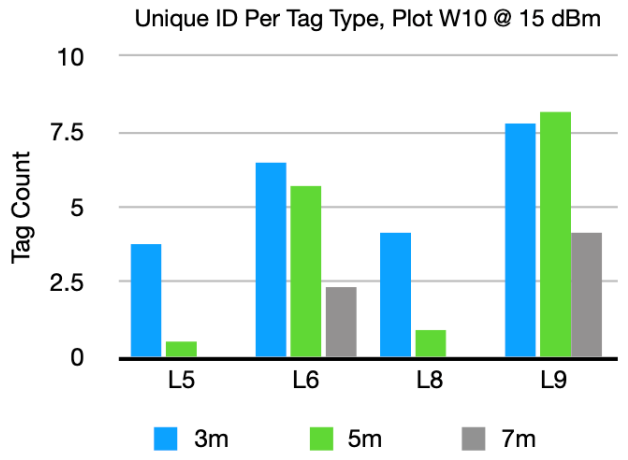
W7

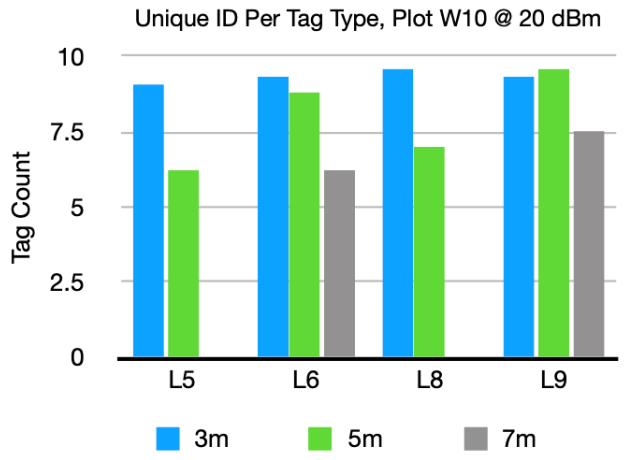


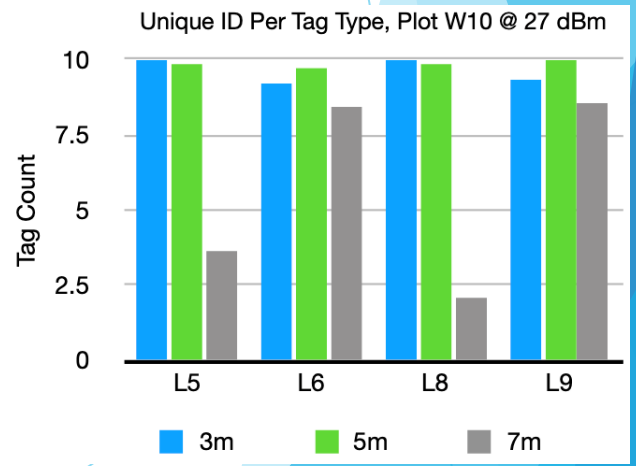




W10







Average of unique tags detected per tag type for plot W7 and W10.

Research

Using RFID, and Drones to Improve Plant Inventory

Scanning Accuracy

W7

RFID pwr	UAV altitude	L5	L6	L8	L9	Total	Accuracy (%)
15 dBm	3 m	2.25	5.58	3.83	9.08	20.75	52
	5 m	0.17	4.17	0.67	8.58	13.58	34
	7 m	0.00	1.25	0.00	5.58	6.83	17
20 dBm	3 m	7.58	8.50	9.17	9.83	35.08	88
	5 m	4.58	7.75	6.58	10.67	29.58	74
	7 m	0.75	3.42	0.08	8.50	12.75	32
27 dBm	3 m	10.00	9.08	10.00	10.00	39.08	**98**
	5 m	9.75	9.33	9.83	9.92	38.83	**97**
	7 m	3.50	7.42	3.83	9.58	24.33	61

W10

RFID Pwr	UAV altitude	L5	L6	L8	L9	Total	Accuracy (%)
15 dBm	3 m	3.81	6.56	4.19	7.75	22.31	56
	5 m	0.56	5.75	0.88	8.13	15.31	39
	7 m	0.00	2.38	0.00	4.13	6.50	16
20 dBm	3 m	9.06	9.31	9.63	9.31	37.31	93
	5 m	6.25	8.81	7.00	9.56	31.63	79
	7 m	0.06	6.25	0.00	7.56	13.88	35
27 dBm	3 m	10.00	9.25	9.94	9.31	38.50	**96**
	5 m	9.81	9.69	9.88	10.00	39.38	**98**
	7 m	3.63	8.38	2.06	8.63	22.69	56

Scanning accuracy at different power setting and height for plot W7 and W10.

Patiluna, V.; Maja, J.M.; Robbins, J. Evaluation of Radio Frequency Identification Power and Unmanned Aerial Vehicle Altitude in Plant Inventory Applications. AgriEngineering 2024, 6, 1319-1334. https://doi.org/10.3390/agriengineering6020076

Research

Using RFID, and Drones to Improve Plant Inventory

Acknowledgment

- This work was partially supported by a grant from Dr. Tanju Karanfil (Vice President of Research) of Clemson University and is based on work supported by NIFA/USDA under project number S1069.
- Special thanks to Avery Dennison Corporation and Mr. Bennett Dudley of R.A. Dudley Nurseries Inc. for their support and assistance in this research.

Next step

- New Funding from the Horticultural Research Institute (HRI) to continue to work on different crop canopies.
- Submitted a Specialty Crop Research Initiative to increase test sites and focus on flight campaign and economics.

Drones at Work: Innovating Inventory Tracking and Management

Joe Mari Maja, Ph.D., MBA

Center of Applied Artificial Intelligence for Sustainable Agriculture

1890 Research & Extension, Public Service and Agriculture

Email: jmaja@scsu.edu

SCiDUC

SC INTERAGENCY DRONE USERS CONSORTIUM

SC State

PUBLIC SERVICE & AGRICULTURE

Innovate. Educate. Elevate.

SCiDUC Symposium
May 30th, 2024

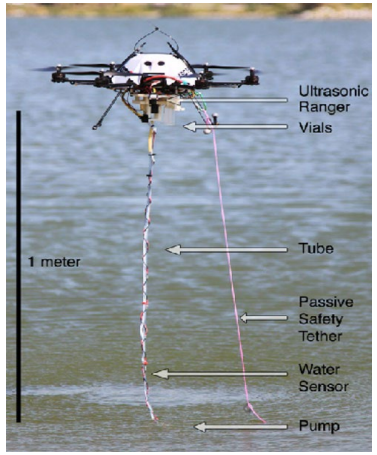
Aerial Drones for Water Sensing and Targeted Sampling

Dr. Nikos Vitzilaios
University of South Carolina

Email: vitzilaios@sc.edu
Website: https://usrl-uofsc.github.io/
LinkedIn: linkedin.com/in/vitzilaios

UAS-based Water Sensing\Sampling

- The use of drones can significantly accelerate water sensing\sampling.
- The concept of using aerial drones for water sensing\sampling is not new, however, previous projects focused either on sensing or sampling.
- Limited payload and flight time constrains the amount of collected sample and multiple sample collection.
- Having the pump at the inlet may harm the living organic matters present in the water before collection.
- Fluorescence-triggered sampling for fluorescent organic matter has not been attempted before.

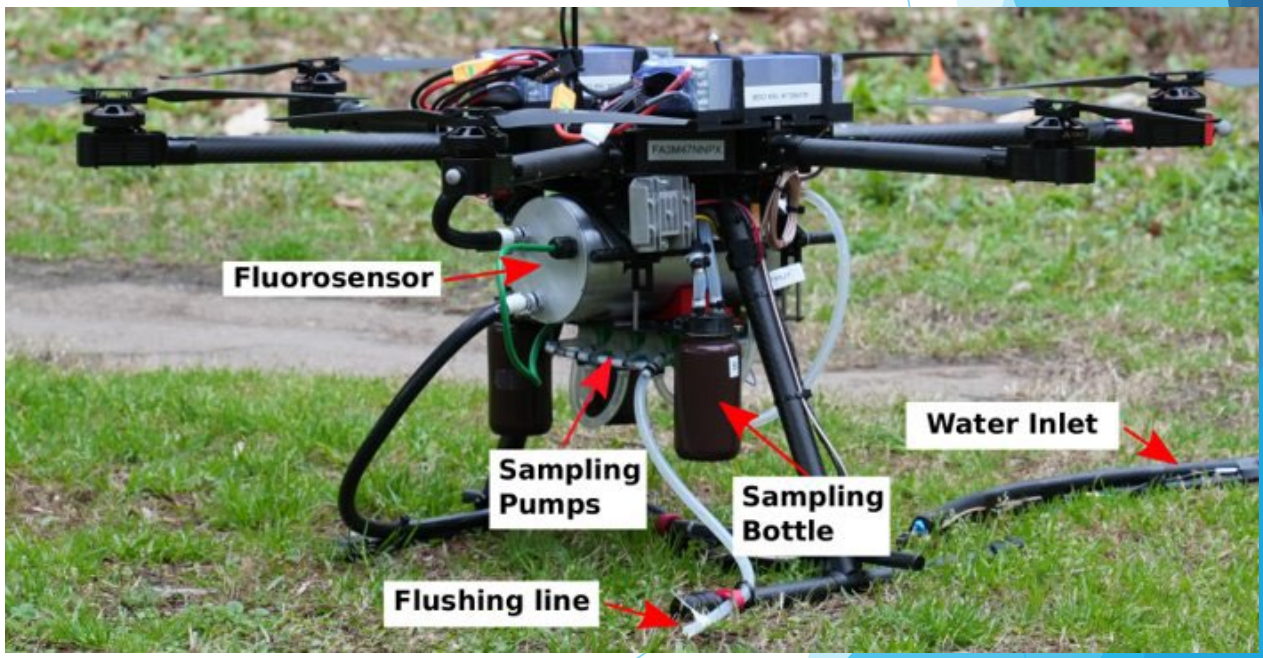


Our Developed System

- Collect 3 samples of 250 mL.
- Autonomous sensor-triggered sample collection.
- Customized control functions to allow different use cases.
- Vacuum-assisted sampling. Therefore, samples don't pass through moving parts of a pump before collection.
- Records data to build a Geographic information system (GIS) framework.

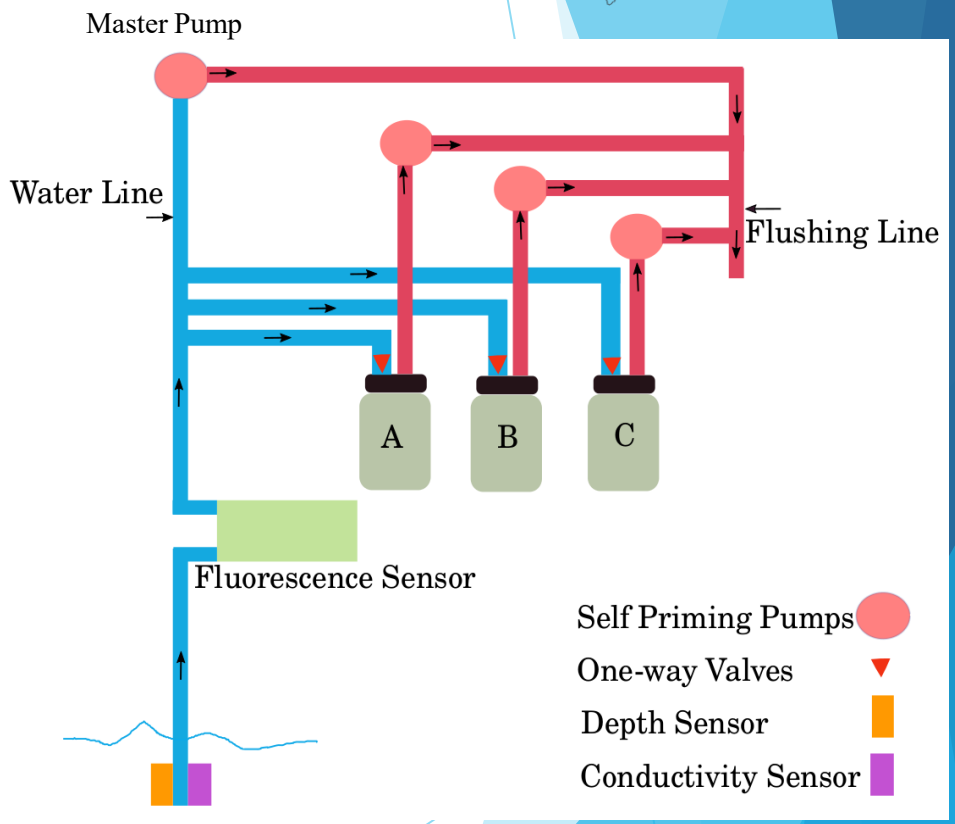
System Design and Development

- UAS Platform
  - Aurelia X6 Standard
  - 5 kg payload excluding batteries
  - TOW: 7170g (empty), 11902g (with WSSA)
  - MTOW: 12170g
  - 45 mins flight time
  - Raspberry Pi 4B as onboard computer
- Water Sensing and Sampling Apparatus (WSSA)
  - 3 bottles of 250 mL each
  - 4 self-priming pumps
  - Fluorescence sensor
  - Depth sensor
  - Conductivity sensor

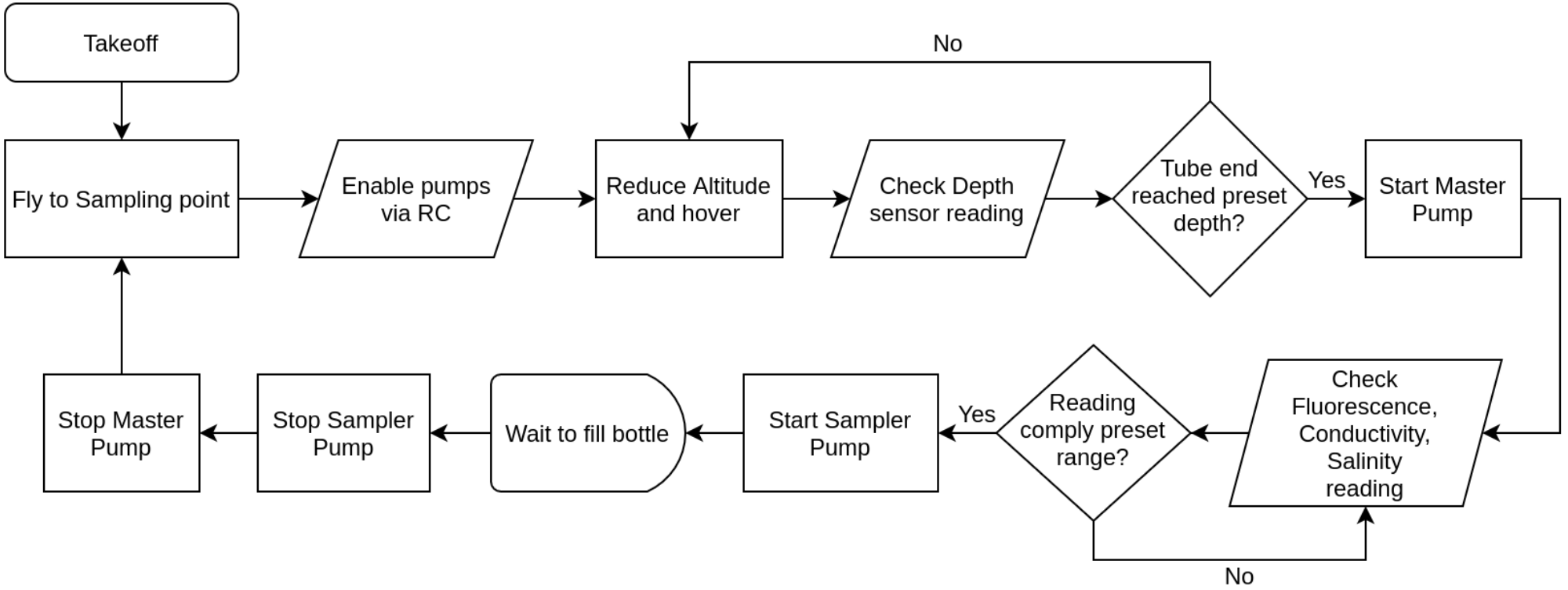


System Design and Development

- Water Sensing and Sampling Apparatus (WSSA)
  - First, the master pump creates a vacuum in the main channel.
  - The one-way valves prevent backflow and facilitate the creation of the vacuum.
  - The vacuum pulls water through the fluorescence sensor into the main channel.
  - A sampler pump creates a vacuum in the corresponding sampling bottle to fill it.
  - When the container is full, water flows out of it, passes through the sampler pump, and exits to the flushing line.



Workflow


Takeoff
Fly to Sampling point
Enable pumps via RC
Reduce Altitude and hover
Check Depth sensor reading
Tube end reached preset depth?
No
Yes
Start Master Pump
Check Fluorescence, Conductivity, Salinity reading
Reading comply preset range?
No
Yes
Start Sampler Pump
Wait to fill bottle
Stop Sampler Pump
Stop Master Pump

Experimental Validation

- Locations
  - A.C. Moore Garden, University of South Carolina, Columbia, SC
  - Lake Wateree, SC
- Two different scenarios were tested:
  1. Go to sampling points and collect 1 bottle of sample in each point.
  2. Sweep across a line to map the fluorescence level.

Moore Garden Trials, USC Campus

Lake Wateree Trials

Questions?

SCiDUC
SC INTERAGENCY DRONE USERS CONSORTIUM

Contact Information

Dr. Nikos Vitzilaios

Department of Mechanical Engineering

University of South Carolina

300 Main Street Rm A219

Columbia SC, 29208

Tel: 803-777-9754

vitzilaios@sc.edu

Mike Proud
Lead Forecaster and
Incident Meteorologist

NWS Drone Usage for Storm Surveys and Damage

MY FORECAST
Columbia SC

Fair

77°F

25°C Get Detailed info

Tonight

Slight Chance T-storms then Partly Cloudy

Low: 65°F

Saturday

Mostly Sunny

High: 84°F

change location

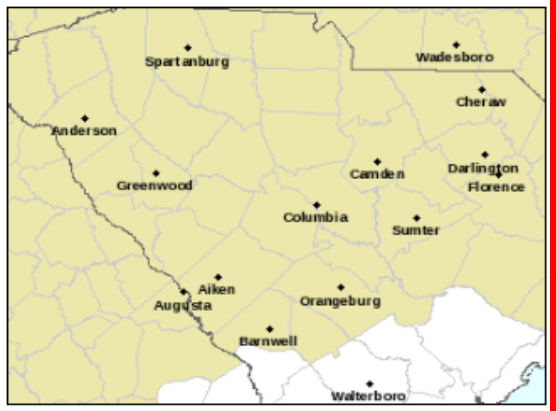
NWS Forecast Office Columbia, SC

Weather.gov > Columbia, SC

Columbia, SC
Weather Forecast Office

Current Hazards | Current Conditions | Radar | Forecasts | Rivers and Lakes | Climate and Past Weather | Local Programs

Click a location below for detailed forecast.



Last Map Update: Fri, Apr. 19, 2024 at 2:59:19 pm EDT

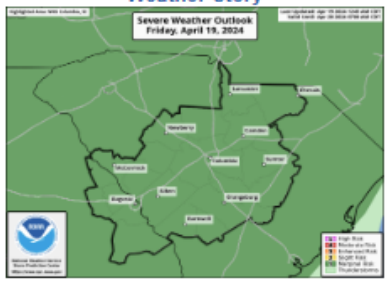
Watches, Warnings & Advisories

Zoom Out

Special Weather Statement

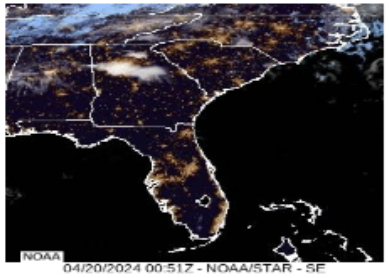
Hazardous Weather Outlook

Weather Story



Local Radar

Satellite



Text Product Selector (Selected product opens in new window)

Latest Text Products Issued by CAE

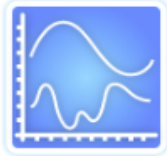

Radar


Current Weather


Rivers & Lakes


Satellite


Forecast Maps


Hour by Hour Forecast

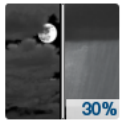
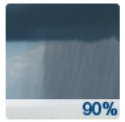
Current conditions at
Columbia, Columbia Metropolitan Airport (KCAE)
Lat: 33.94°N Lon: 81.12°W Elev: 233ft.

Mostly Cloudy
72°F
22°C

Humidity	68%
Wind Speed	S 16 mph
Barometer	30.09 in (1018.6 mb)
Dewpoint	61°F (16°C)
Visibility	10.00 mi
Last update	10 Apr 10:56 am EDT

More Information:
Local Forecast Office
More Local Wx
3 Day History
Mobile Weather
Hourly Weather Forecast

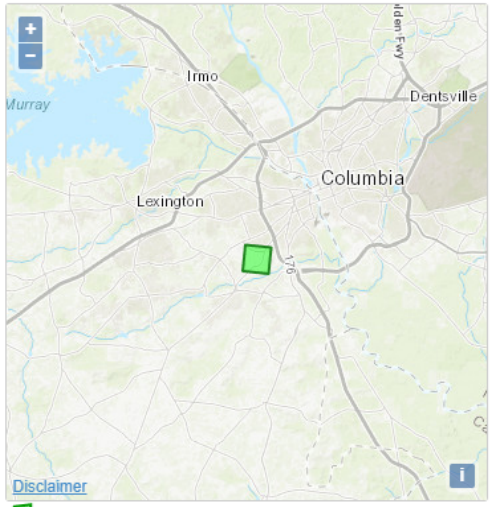
Extended Forecast for
Columbia Metropolitan Airport SC

Today	Tonight	Thursday	Thursday Night	Friday	Friday Night	Saturday	Saturday Night	Sunday
								
Partly Sunny	Mostly Cloudy then Chance Showers	Showers and Breezy	Chance Showers then Mostly Clear	Sunny then Sunny and Breezy	Clear	Sunny	Clear	Sunny
High: 80 °F	Low: 66 °F	High: 77 °F	Low: 54 °F	High: 73 °F	Low: 47 °F	High: 77 °F	Low: 52 °F	High: 84 °F

Detailed Forecast

Today	Partly sunny, with a high near 80. South wind around 10 mph.
Tonight	A chance of showers, mainly after 4am. Mostly cloudy, with a low around 66. Southeast wind 10 to 14 mph. Chance of precipitation is 30%. New precipitation amounts between a quarter and half of an inch possible.
Thursday	Showers and thunderstorms before 2pm, then showers likely and possibly a thunderstorm between 2pm and 4pm, then a chance of showers and thunderstorms after 4pm. High near 77. Breezy, with a south wind 21 to 23 mph, with gusts as high as 37 mph. Chance of precipitation is 90%. New rainfall amounts between a half and three quarters of an inch possible.
Thursday Night	A chance of showers and thunderstorms, mainly before 8pm. Partly cloudy, with a low around 54. Southwest wind around 18 mph, with gusts as high as 28 mph. Chance of precipitation is 30%. New precipitation amounts of less than a tenth of an inch, except higher amounts possible in thunderstorms.
Friday	Sunny, with a high near 73. Breezy, with a west wind 13 to 23 mph, with gusts as high as 37 mph.
Friday Night	Clear, with a low around 47.
Saturday	Sunny, with a high near 77.
Saturday Night	Clear, with a low around 52.
Sunday	Sunny, with a high near 84.
Sunday Night	Mostly clear, with a low around 58.
Monday	Sunny, with a high near 86.
Monday Night	Mostly clear, with a low around 59.
Tuesday	Mostly sunny, with a high near 86.

Topographic
Click Map For Forecast



Forecast Area

Point Forecast: Columbia Metropolitan Airport SC
33.94°N 81.11°W (Elev. 207 ft)
Last Update: 2:59 am EDT Apr 10, 2024
Forecast Valid: 11am EDT Apr 10, 2024-6pm EDT Apr 16, 2024

Saturday Night	Clear, with a low around 52.
Sunday	Sunny, with a high near 84.
Sunday Night	Mostly clear, with a low around 58.
Monday	Sunny, with a high near 86.
Monday Night	Mostly clear, with a low around 59.
Tuesday	Mostly sunny, with a high near 86.

Additional Forecasts and Information

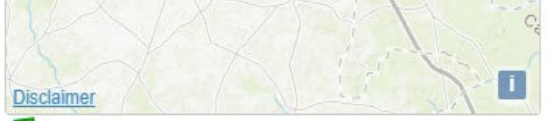
ZONE AREA FORECAST FOR LEXINGTON COUNTY, SC

Forecast Discussion
Printable Forecast
Text Only Forecast

Hourly Weather Forecast
Tabular Forecast

Hazardous Weather

Air Quality Forecasts
International System of Units



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Last Update: 2:59 am EDT Apr 10, 2024

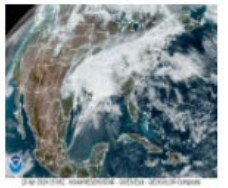
Forecast Valid: 11am EDT Apr 10, 2024-6pm EDT Apr 16, 2024

Forecast Discussion

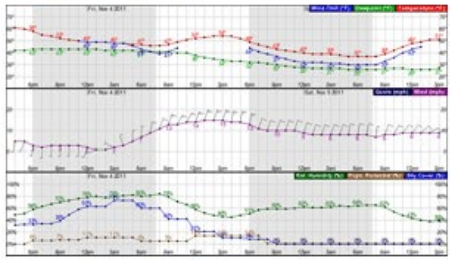
KML XML

Additional Resources

Radar & Satellite Image

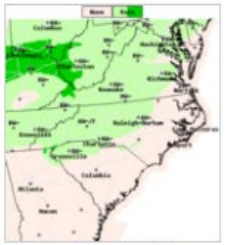


Hourly Weather Forecast



National Digital Forecast Database

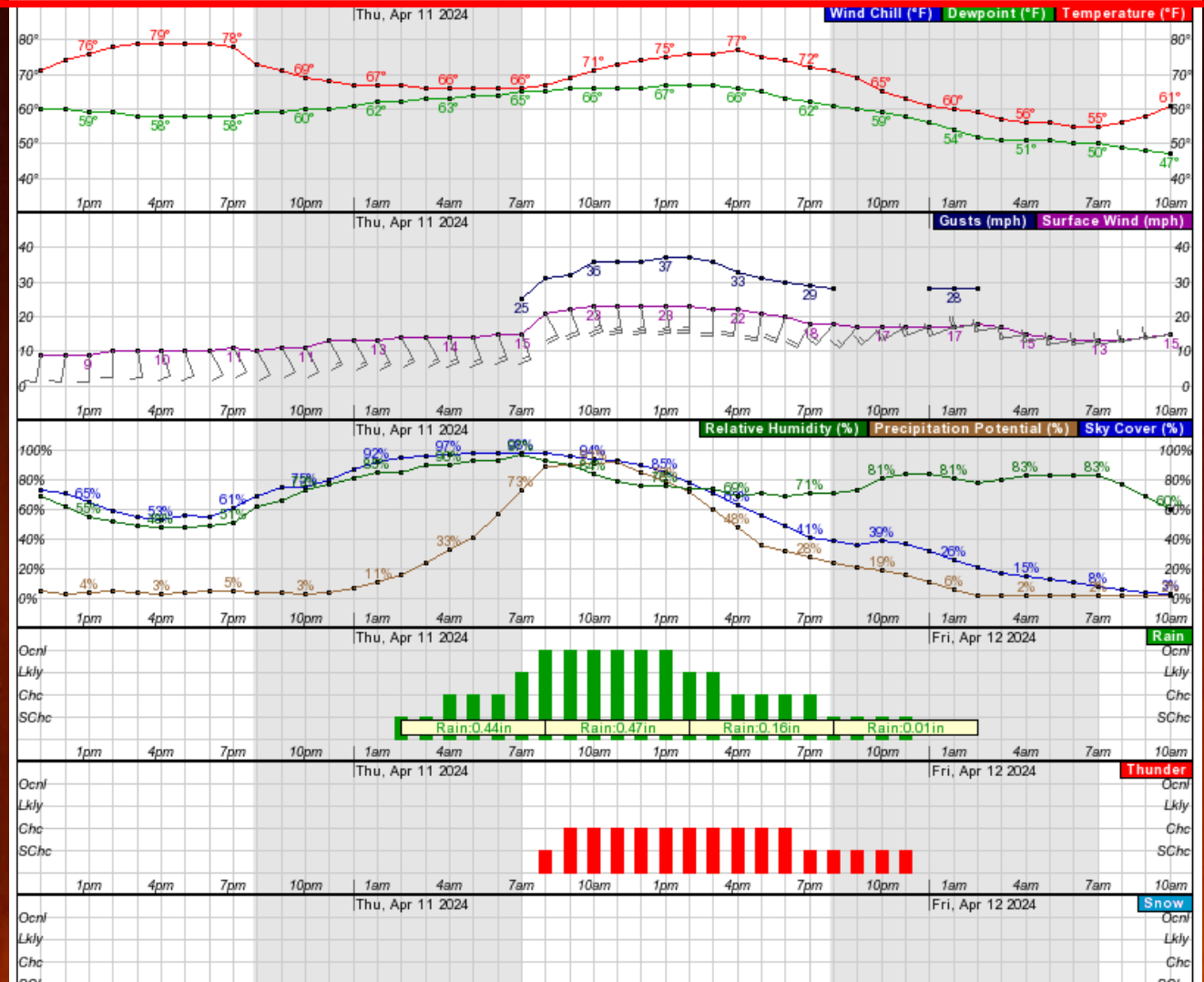
High Temperature



Chance of Precipitation

Weather Elements	Weather/Precipitation	Fire Weather
☑ Temperature (°F) ☑ Dewpoint (°F) ☑ Wind Chill (°F) ☑ Surface Wind mph ☑ Sky Cover (%) ☑ Precipitation Potential (%) ☑ Relative Humidity (%)	☑ Rain ☑ Thunder ☑ Snow ☑ Freezing Rain ☑ Sleet ☐ Fog	☐ Mixing Height x100ft ☐ Haines Index ☐ Lightning Activity Level ☐ Trans. Wind mph ☐ Vent Rate (x1000 mph-ft) ☐ Davis Stability Index ☐ Atmospheric Dispersion Index ☐ Low Visibility Occurrence Risk Index

48-Hour Period Starting: 11am Wed, Apr 10 2024 | Submit | Back 2 Days | Forward 2 Days



Weather Elements	Weather/Precipitation	Fire Weather
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48-Hour Period Starting: 11am Wed, Apr 10 2024 | Submit | Back 2 Days | Forward 2 Days

Date	04/10													04/11										
Hour (EDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10
Temperature (°F)	71	74	76	78	79	79	79	79	78	73	71	69	68	67	67	67	66	66	66	66	66	67	69	71
Dewpoint (°F)	60	60	59	59	58	58	58	58	58	59	59	60	60	61	62	62	63	63	64	64	65	65	66	66
Wind Chill (°F)																								
Surface Wind (mph)	9	9	9	10	10	10	10	10	11	10	11	11	13	13	13	14	14	14	14	15	15	21	22	23
Wind Dir	S	S	S	S	S	S	S	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	S	S	S	S	SE	S	S
Gust																					25	31	32	36
Sky Cover (%)	73	71	65	59	55	53	56	55	61	69	75	75	80	87	92	95	96	97	98	98	98	98	96	94
Precipitation Potential (%)	5	3	4	5	4	3	4	5	5	4	4	3	4	7	11	16	24	33	41	57	73	89	90	91
Relative Humidity (%)	69	62	55	52	49	48	48	49	51	62	66	73	77	81	85	85	90	90	93	93	97	93	90	84
Rain	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	SChc	SChc	Chc	Chc	Chc	Lkly	Ocnl	Ocnl	Ocnl
Thunder	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	SChc	Chc	Chc
Snow	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Freezing Rain	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sleet	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Date														04/12										
Hour (EDT)	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10
Temperature (°F)	73	74	75	76	76	77	75	74	72	71	69	65	63	61	60	59	57	56	56	55	55	56	58	61
Dewpoint (°F)	66	66	67	67	67	66	65	63	62	61	60	59	58	56	54	52	51	51	51	50	50	49	48	47
Wind Chill (°F)																								
Surface Wind (mph)	23	23	23	23	22	22	21	20	18	18	17	17	17	17	17	18	17	15	14	13	13	13	14	15
Wind Dir	S	S	S	S	S	S	S	S	SW	SW	SW	SW	SW	W	W	W	W	W	W	W	W	W	W	W
Gust	36	36	37	37	36	33	31	30	29	28				28	28	28								
Sky Cover (%)	93	90	85	78	71	63	56	49	41	39	36	39	37	32	26	21	17	15	13	11	8	6	4	3
Precipitation Potential (%)	92	85	79	72	60	48	36	32	28	24	21	19	16	11	6	2	2	2	2	2	2	2	2	2
Relative Humidity (%)	79	76	76	74	74	69	71	69	71	71	73	81	84	84	81	78	80	83	83	83	83	77	69	60
Rain	Ocnl	Ocnl	Ocnl	Lkly	Lkly	Chc	Chc	Chc	Chc	SChc	SChc	SChc	SChc	--	--	--	--	--	--	--	--	--	--	--
Thunder	Chc	Chc	Chc	Chc	Chc	Chc	Chc	Chc	SChc	SChc	SChc	SChc	SChc	--	--	--	--	--	--	--	--	--	--	--
Snow	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Freezing Rain	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sleet	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

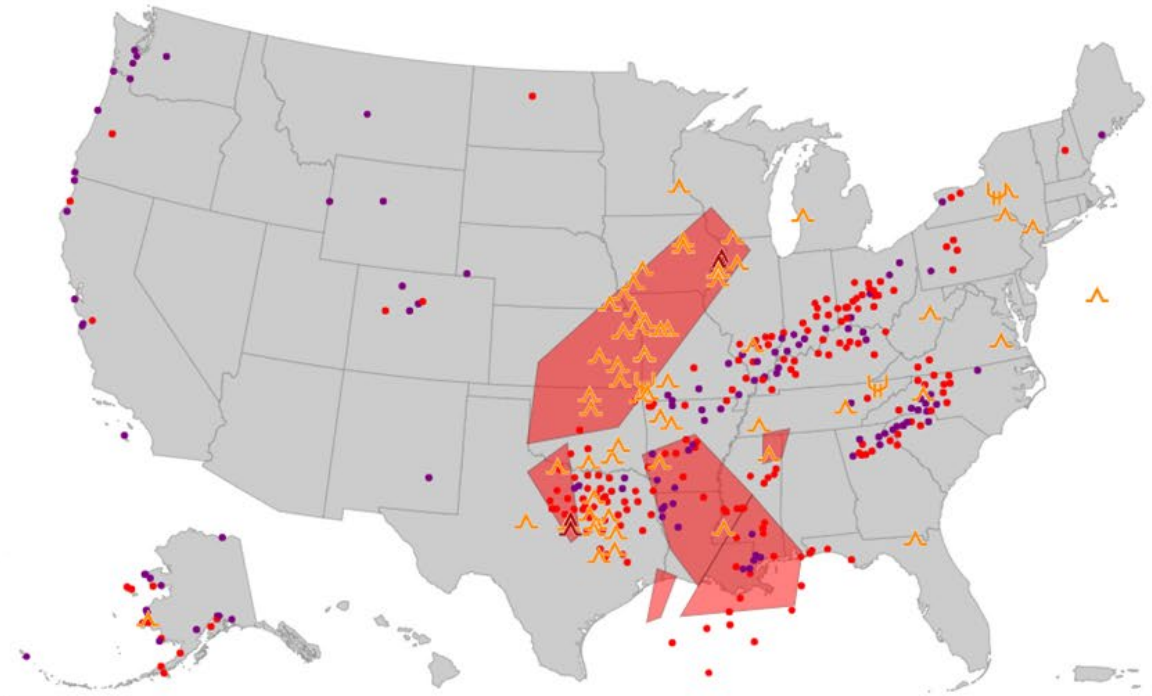
Aviation Weather Center Weather Products Tools Connect

https://aviationweather.gov/

Welcome!

New look and feel for AWC! Try it on your phone or tablet!

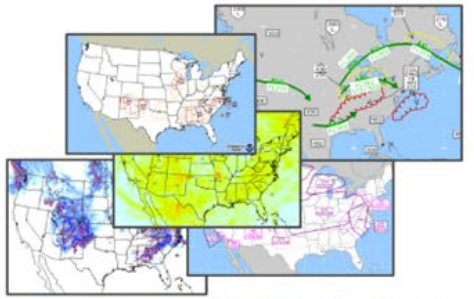
Current Conditions



Graphical Forecasts for Aviation

Interactive maps of aviation forecasts and observations

Decision Support Imagery



Static DSS images to embed in briefing material

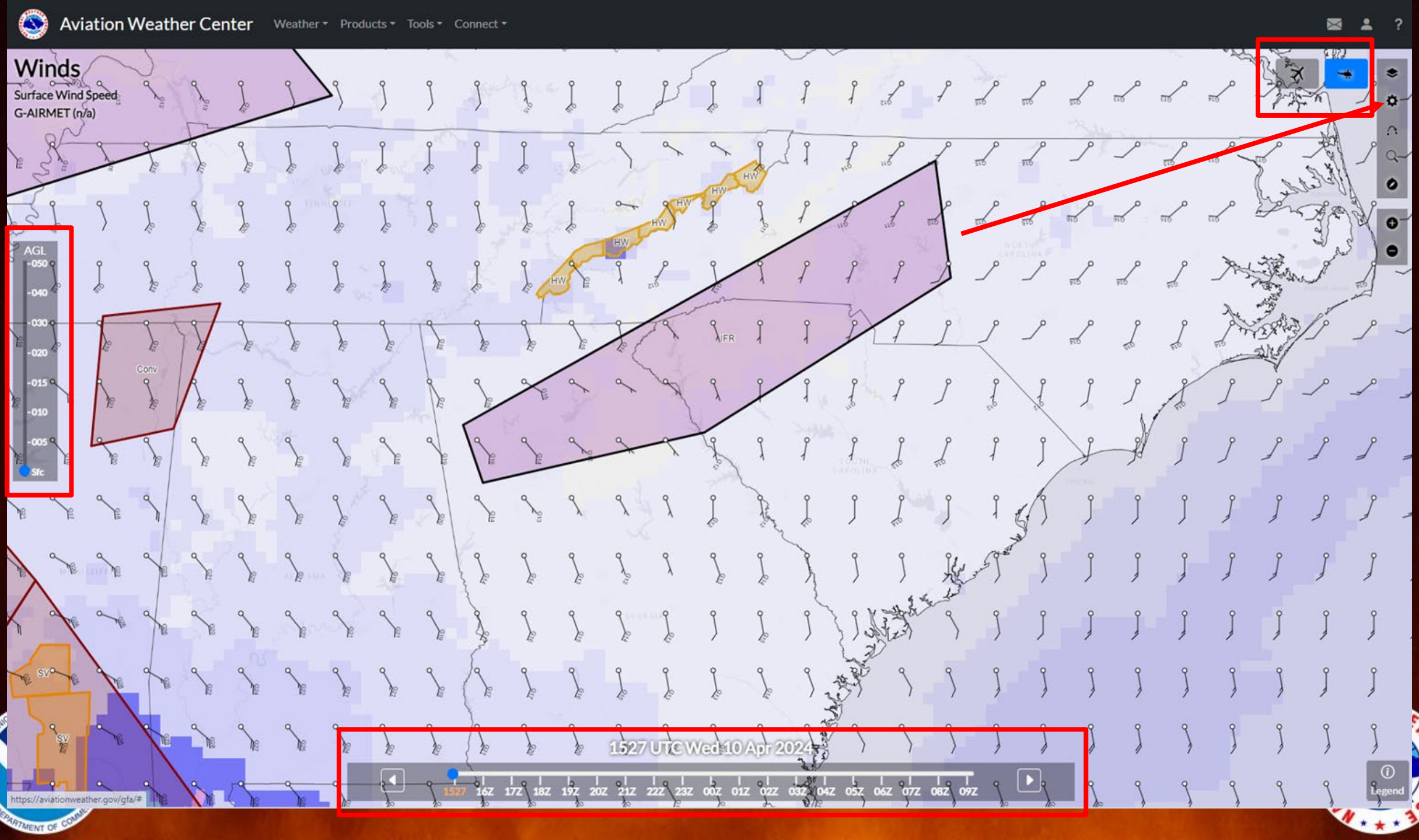
Station data

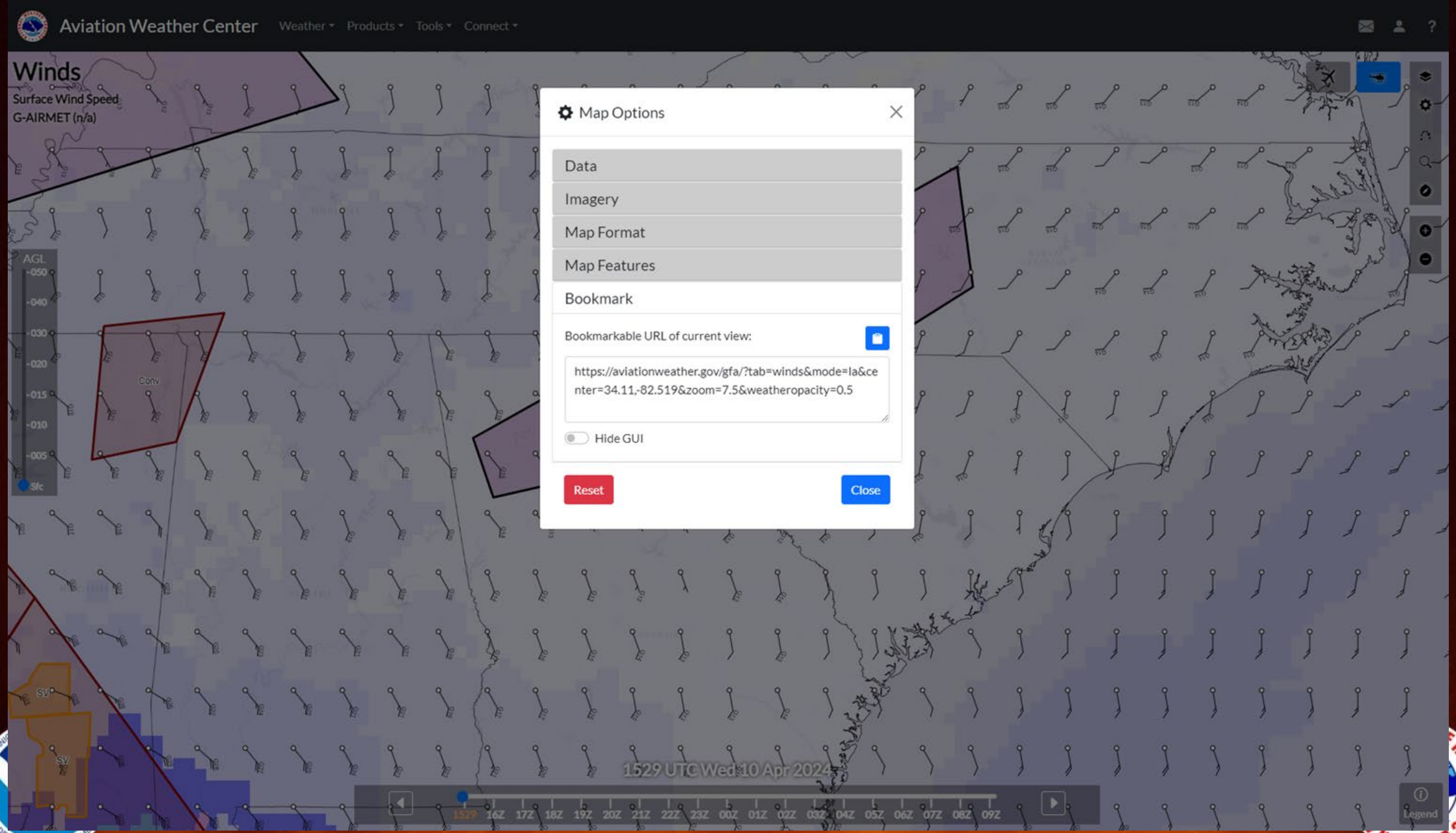
IDs: KMCI Most recent

Raw Decoded Remember Go Expand

Where is...?

- Fully integrated GFA maps — accessed through the Weather menu
- HEMS Tool is now GFA-LA — all of the same features and more
- Radar, satellite, METARs, and other current data on the observation map
- Text Data Server has been replaced by the Data API
- Raw and decoded METAR and TAF data
- Public hourly forecasts are available through Weather.gov


Aviation Weather Center
Weather
Products
Tools
Connect
Winds
Surface Wind Speed
G-AIRMET (n/a)
AGL
050
040
030
020
015
010
005
Sfc
Conv
HW
IFR
SV
1527 UTC Wed 10 Apr 2024
1527 16Z 17Z 18Z 19Z 20Z 21Z 22Z 23Z 00Z 01Z 02Z 03Z 04Z 05Z 06Z 07Z 08Z 09Z
Legend
https://aviationweather.gov/gfa/#

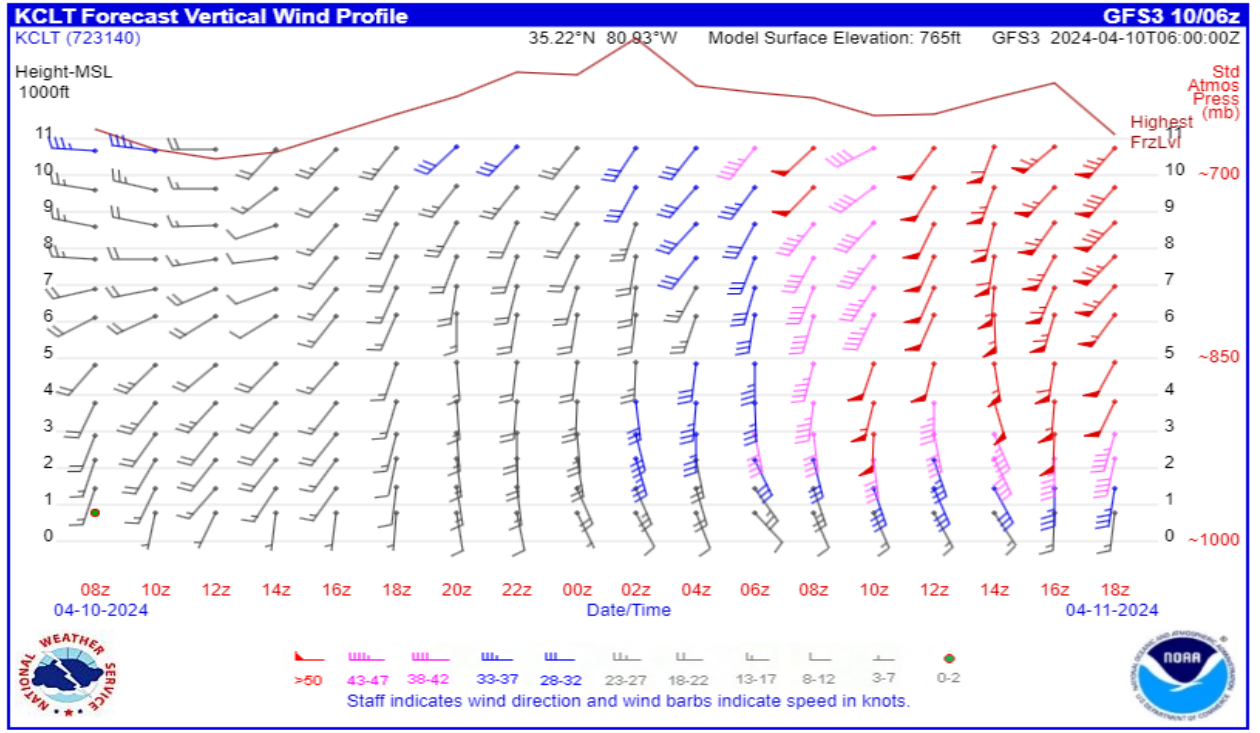

Aviation Weather Center
Weather
Products
Tools
Connect
Winds
Surface Wind Speed
G-AIRMET (n/a)
AGL
050
040
030
020
015
010
005
Sfc
Conv
SV
SV
Map Options
Data
Imagery
Map Format
Map Features
Bookmark
Bookmarkable URL of current view:
https://aviationweather.gov/gfa/?tab=winds&mode=la&center=34.11,-82.519&zoom=7.5&weatheropacity=0.5
Hide GUI
Reset
Close
1529 UTC Wed 10 Apr 2024
15Z
16Z
17Z
18Z
19Z
20Z
21Z
22Z
23Z
00Z
01Z
02Z
03Z
04Z
05Z
06Z
07Z
08Z
09Z
Legend

ZSE Model VWP

Seattle, WA
Center Weather Service Unit

Site: CLT | Height (ft AGL): 10,000 | Output: Wind Barb | Table: No / Yes | Tail/Head/Cross Wind: No / Tail/Head / Cross | Runway: none | Model: Multiple | Tooltips: | Display | Help/ Info

Select: HRRR RAP NAM *GFS* Hover



This graphic displays forecast vertical wind profiles over the selected location from the surface to 20,000 feet AGL. Forecast winds are displayed at 2-hour intervals out through 36 hours. The graphic is updated based on the latest run of the GFS model. Wind speeds are color-coded with with speeds 28-37kt displayed in blue, 38-47kt in pink, and winds greater than 47kt in red. Wind direction is indicated by the staff using a 360° compass, where 180° indicates a south wind and 360° a north wind. The solid red line indicates the highest forecast freezing level over time.

KCLT Model Output — GFS3 2024-04-10T06:00:00Z

Time	08z	10z	12z	14z	16z	18z	20z	22z	00z	02z	04z	06z	08z	10z	12z	14z	16z	18z	Index
LI	4.95	4.65	4.55	4.12	3.73	1.3	0.6	0.3	2.16	2.57	2.87	4.22	3.43	1.73	0.84	0.98	0.01	0.42	LI
K	28	29	30	31	30	15	20	20	12	5	15	29	32	32	35	33	36	22	K
SWEAT	292	270	269	264	273	172	332	298	263	264	201	334	374	324	404	443	442	303	SWEAT
SHOW	4.57	3.85	3.92	3.71	3.99	3.7	0.66	1.65	3.75	5.4	4.15	4.09	2.88	1.77	0.92	2.03	0.07	5.76	SHOW
TOTL	42	43	43	44	43	44	48	47	43	41	43	42	43	45	46	43	46	40	TOTL
CAPE	0	0	0	0	0	20	20	45	23	1	14	0	0	11	49	67	101	191	CAPE
CIN	0	0	0	0	0	0	-1	-16	-47	-52	-49	0	-28	-63	-4	0	0	0	CIN
PW	1.28	1.34	1.39	1.39	1.32	1.09	1.11	1.07	1.04	1.12	1.14	1.45	1.58	1.55	1.64	1.7	1.62	0.92	PW
BRN	0	0	0	0	0	0.55	0.53	1.54	0.69	0.03	0.28	0	0	0.12	0.33	0.41	0.63	1.02	BRN
WIND	185/02	187/03	203/03	187/03	187/03	180/06	171/09	168/08	155/07	154/09	160/09	138/10	160/11	157/15	152/13	148/13	182/17	184/16	Sfc(°/kt)
LLWS	17-020	19-020	18-020	18-020	15-020	7-020	7-020	12-020	19-015	24-015	25-020	28-020	25-020	34-020	28-020	29-020	30-020	28-020	(kt-hgt)

Questions?

Internet Links

NWS Columbia Homepage
https://www.weather.gov/cae/

Hourly Weather Graph for NWS Columbia
https://forecast.weather.gov/gridpoint.php?site=cae&TypeDefault=graphical

Aviation Weather Center
https://aviationweather.gov/

Forecast Vertical Wind Profile
https://www.weather.gov/zse/ZSEModelVWP?site=kxxx&height=10&output=barb&table=yes&tailwind=no&runway=00&model=multiple&tooltips=on#ZSEcontent

***NOTE: Make xxx the nearest airport, not all airports will work

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Thank you!!!

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